"Heliography; or, the Actinic Copying of Engineering Drawings."*

BY BENJAMIN HOWARTH THWAITE, ASSOC. M. INST. C. E.

The advantages of rapidity and fidelity of reproduction possessed by the actinic copying method are already well known; but the following notes on the most modern practice may be interesting to engineers.

Sir John Herschel, who was probably the first to employ photographic printing for purely scientific purposes, used a cyanotype process for reproducing his astronomical tables.

In 1840, a Paper was submitted to the Institution by Mr. Alexander Gordon, entitled, "Photography as applicable to Engineering," in which Mr. Gordon described Daguerre's discovery, pointing out the advantages it offered to the engineering profession, and recommending the silver printing as a ready means of obtaining duplicates of drawings.[1] Engineers did not, however, employ heliography to any great extent until the ferro-prussiate, or cyanotype, commonly called the blue-copy process, was introduced, when the advantages of cyanotype heliography became manifest; and, in some instances, the simple apparatus required for this method has been extended into complete photographic ateliers. The Midland Railway Company; Krupp, of Essen; Sir W. Armstrong and Co., of Newcastle; and Siemens and Halske, of Berlin, have photographic departments. The latter firm, in its Berlin establishment, employs a powerful electric arc-light of 6,000 candles, around which the printing-frames are placed; and both the platinotype and Pellet processes, have given successful results with the arc-light.

The heliographic apparatus includes tracing paper or cloth, printing frames, a developing bath, non-actinic arrangements, and cases for storing paper.

Thin bluish tracing-paper is the best; the more translucent it is, and the stronger, the better. After the tracing has been made, it should be preserved from light, as exposure to light gradually renders tracing-paper more opaque. The tracings should never be folded, but kept perfectly flat, or rolled. Drawings on ordinary drawing paper, or from illustrated papers, can be copied if they are exposed to the light sufficiently long, the duration of exposure depending on the thickness or transparency of the paper. When the drawing only shows half the section of the figure to be traced, the full section can be shown by tracing the other half on the back of the tracing-paper; the sun-copying reproduction is precisely the same as if the tracing had only been made on one side; and all the writing and dimension should be on the front side. Translucent drawing parchment paper, specially prepared for the sun-copying processes, can now be obtained. The dimension-lines for the ferro-prussiate, or cyanotype negative, should either be dotted or ruled in Indian ink, chrome yellow, or raw sienna; or if in Prussian blue or carmine, the colors should be made more opaque by a slight admixture of flake, or Chinese white. In copying by the ferro-prussiate or cyanotype processes, the sectional parts of the figure should be cross-hatched; or the sectional parts can be colored with shades slightly less opaque than the linear portions, by the addition of an opaque color such as Chinese white; and as these sectional parts of the print are reproduced almost white, they can be colored with the usual conventional colors, which could hardly be done on a blue ground. The Pellet and Shawcross methods allow of the ordinary conventional colors being used without this preliminary preparation. The best Indian ink should be employed, its opacity being increased by the addition of gamboge or chrome yellow.

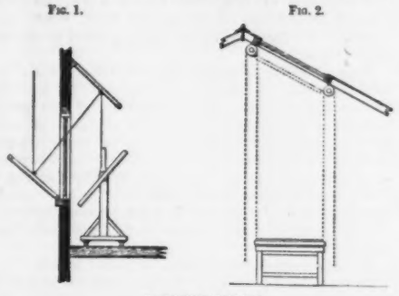
The printing-frame is the most important part of the apparatus, as upon its merits depends much of the success, both as regards accuracy and legibility. If the tracing and the sensitized paper are not brought into close contact with each other, the actinic rays pass under the lines of the drawing, which are thus either obliterated or contorted. The pressure should be uniformly distributed, to bring the sensitive and tracing papers into close contact, as any local pressure produces irregularities and false impressions, causing wrinkles in the tracing-paper, the shadows of which are reproduced. In order to test the shrinkage of the paper, the scales should be drawn on the tracing in two directions, at right angles. The shrinkage of strong Pellet or cyanotype paper is equal to 0.005.

The form of frame is very simple. The glass should be ¼-inch plate, free from blemishes; and the author has used 26-ounces glass for small frames. A piece of soft felt, ½ inch thick, the full size of the frames, should be used to equalize the pressure, or a piece of folded flannel will serve the purpose admirably; and it is well to use india rubber sheets, sewn to the edges of the flannel or felt.

The most useful sizes for the printing-frame are 12 by 14, 19 by 26 for Royal, 22 by 30 for Imperial, 30 by 43 for Double Elephant, and 40 by 56 inches.

The method devised by the author for hanging the printing-frames is shown in Fig. 1, whereby the printing frame can be inclined at any angle. This frame is adapted for offices in which space is limited, and in combination with the author's arrangement with de-

FIG. 1. FIG. 2.



PRINTING FRAMES.

velopement bath, forms all the apparatus necessary for the Herschel, cyanotype, and Shawcross processes. Where diffused light alone reaches the office, owing to the obstruction of neighboring buildings, reflecting frames can be used (Fig. 1); or the printing frame may be hoisted to the roof fanlight by pulleys (Fig. 2.)

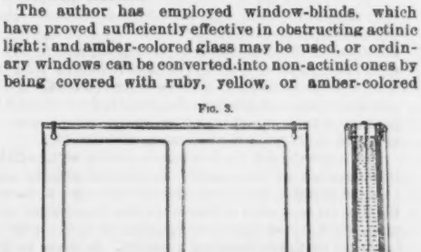
The tracing is placed with its figured face next the glass, and the sensitized paper, with its prepared face next to the tracing, is carefully and uniformly pressed into contact with it. The felt is next laid upon the paper, in such a way as not to disturb the position of the tracing or the sensitized paper. The back board is then placed on the felt, the clamping-bars are fixed in position, and the face of the frame is exposed to the sun at such an angle as to be nearly as possible at right angles to the solar rays. There should not be any obstacle, such as window mullions, etc., intervening between the printing frame and the source of light, as any partial obstruction of the rays would produce an imperfect copy. Where practicable, the printing-frame should be exposed in the open air, to the full rays of the sun, or to the brightest part of the sky, preferably placing the face of the frame flat, so as to get the direct rays from the zenith, and with no wall near it to obstruct the light. If such a wall exists, it should be colored white, to reflect as much of the actinic as possible. If this is not possible, the frame should be exposed for half the time of exposure turned in one direction, and then reversed end for end for the remainder.

Instead of springs or clamps on the printing-frame, use may be made of Street's copying frames, with an air cushion inflated by simply blowing, and exerting a uniform pressure over the whole surface of the frame.

The sensitive paper should be taken from its case in non-actinic light. This is especially important with papers sensitized by process Nos. 3, 4, 5, and 6, described further on.

The author has employed window-blinds, which have proved sufficiently effective in obstructing actinic light; and amber-colored glass may be used, or ordinary windows can be converted into non-actinic ones by being covered with ruby, yellow, or amber-colored

FIG. 3.



DEVELOPING BATH.

glacial paper. The light of any office can thus be made non-actinic at a slight expense. The author sensitizes the paper in the evening, using a ruby lantern. When the paper has been prepared by the cyanotype processes or the gallic acid process, non-actinic arrangements are superfluous, as these papers may be freely handled in the diffused light of an office for the short time required to cut and place the sensitized paper in the printing frame.

The developing bath should be slightly larger than the paper to be treated. For acid solutions, the bath should be of earthenware, papier maché, vulcanite or enamelled iron; but for most of the solutions mentioned in this Paper, the bath may be of zinc, or of wood lined with gutta-percha, or sheet lead.

For the Pellet process, two trays lined with gutta-percha, and one zinc tray, will be required. A copious supply of water to the bath, from a 1-inch rubber tube attached to a water-tap, will be found a great advantage. The print, on its removal from the frame, should be rapidly transferred to the bath, and after being immersed in pure water until it is completely developed, should be withdrawn and hung upon a line, or on glass rods with clips until the water has drained off; and blotting-paper will then effectually remove remaining moisture.

A wooden bath may be employed if, when perfectly dry, it is treated with a varnish of ¼ pound of common brown resin and 2 ounces of beeswax. The developing bath designed by the author (Fig. 3) is well suited for offices where space is limited, as it is more portable than the flat form of bath, and occupies little space; the water cleares itself from the dissolved salts, and the prints are more easily developed. The prints, when in the bath, are removed from the light, and when withdrawn they can be hung on the drying-rods at the sides of the bath, the water draining into the troughs at each side.

The sensitized paper should be preserved from damp and the light in zinc cases. Where the locality is a damp one, it is a good plan to have the lid fitted to hold a piece of calcic chloride, to absorb the moisture.

No. 1.—*Cyanotype Sensitizing Process (Herschel's.—)* White lines are produced on a blue ground with a solution of 140 grains of ferric-ammonic citrate, 120 grains of potassic ferri-cyanide, and 2 ounces of distilled water; and the solution should be kept in a stoneware vessel.

This process depends upon the actinic action of light reducing the ferric salts to a ferrous state under certain conditions, one of which is the presence of organic matter, such as the albumen or other size contained in the paper. The ferrous salt then combines with the potassic salt to form Prussian blue, which is insoluble.

The sensitizing solution should be applied to cream-laid paper, rolled and well sized by a flat damping brush, 6 inches wide, or a tuft of cotton-waste; and the paper should be allowed to dry in the dark. The solution should be applied uniformly, and sufficiently just to cover the surface of the paper. After drying in the dark, the paper should be rolled and stored in special cases.

Two or three minutes' exposure to the sun at noon, and thirty minutes in the afternoon, is sufficient when newly-made sensitized paper is used. The exact degree of printing during exposure can be ascertained by the use of a small printing-frame, in which sensitized paper should be exposed along with that in the larger frame, and under precisely similar conditions. Another method is to allow a part of the sensitizing paper to protrude from behind the tracing. The effect of the degree of exposure can be ascertained by watching the varying colors of the paper, which, with the blue negative cyanotype processes, change from an initial yellowish green to a bluish green, then to bluish grey, and finally to an olive green, when the exposure is complete.

A 6,000 candle arc-light is equal to half the actinic effect of ordinary sunless noonday light, and equal to one-sixth of the actinic effect of unclouded sunlight. At a distance of 5 feet from the electric arc-light of 6,000 candles, an exposure of thirty minutes is required for paper sensitized by the Pellet process, and a little longer for the other cyanotype processes. As the argentic paper is four times more sensitive than the cyanotype paper, about ten minutes' exposure only is needed for paper sensitized by the argentic nitrate process. By arranging several printing-frames in a circle of ten feet around the arc-light, as many as eight large copies can be made at the same time.

When it is required to copy during dark days, and where the electric arc-light is not available, actinic light may be produced by a deflagrating mixture of eight parts of potassic chlorate, four parts of antimony sulphide, two parts of sulphur, and two parts of magnesium dust; but it is only suitable for the highly sensitive argentic nitrate, and platinotype processes, and must not be pounded or otherwise mixed in a mortar.

The development is effected by thoroughly washing the print in pure water, in the bath, for a few minutes. A little hydric chloride is occasionally added to the water to increase the intensity of the blue ground, which may be converted into black by first immersing it in a bath of caustic potash, and afterwards in one of tannic acid. Development is considerably accelerated by the use of water at 90° to 100° Fahrenheit. Only sufficient paper for two months' use should be obtained.

No. 2.—*Cyanotype Process (Marion's).*—White lines on a blue ground are also produced by a sensitizing solution composed of 9¾ ounces of ferric-ammonia citrate, and 6¼ ounces of potassic-ferric oxide, dissolved separately in pure water, and then made up to one quart.

Both processes Nos. 1 and 2 give good results. When positive prints (or blue lines on a white ground) are required, the sensitive paper should be of the thinnest possible description that will permit the solution to be applied without sinking through it. This thin

*From Proceedings of the Institution of Civil Engineers.

[1] Minutes of Proceedings Inst. C. E. vol. i. (1840), p. 57.

paper should be then used in the manner described for taking a negative copy (or white line on a blue ground), this negative copy being used instead of the tracings, and the ordinary sensitized parer placed behind it in the manner. The exposure must be considerably prolonged (from three to four times at least); and the development also occupies a longer time.

To effect alterations or additions to negative prints, the following methods may be adopted. White lines may be obliterated by applying a quill-pen or brush dipped in the sensitizing solution, and then exposing and developing as already described. Additions may be made with flake,[or Chinese white; but a more effectual method is to use a quill-pen, or brush, dipped into a solution of 40 grains of potassic carbonate in 1 ounce of water. Immediately after applying the potash the paper must be carefully dried with blotting-paper, otherwise the effect of the solution will spread.

No. 3.—*Positive Cyanotype Process (Pellet's. Blue lines on a white ground).*—According to an admirable treatise,[2] this process is the most important of the existing sun-copying or photographic-tracing methods. It is widely used by engineers on the Continent; it gives very distinct prints, and depends upon the reduction of an organic ferric salt to a ferrous salt by actinism. Prussian blue is formed by the reaction of ferric compounds with potassic ferro-cyanide; and white ferrous compounds form a white salt with the same reagent. If the paper sensitized by the Pellet process was introduced into the ferrocyanide developer without exposure, it would become entirely blue, owing to the uniform deposition of Prussian blue Should any part have been sufficiently exposed to the light, the paper will remain white, owing to the complete reduction of the iron from the ferric to the ferrous state, the persalt of iron becoming reduced to the state of protosalt wherever the sensitive paper is unprotected by the opaque lines of the tracing. Hence the Pellet process produces dark blue lines on a white ground. The solution is made with three parts of hydrogen tartrate, and one hundred parts of water; and it is thickened by the addition of twenty-five parts of powdered gum-arabic. The paper should be fastened down by pins, and the solution applied in the usual manner. The paper should be dried as quickly as possible, to keep the sensitive coating as much as possible on the surface of the paper.

In full sun light, one to two minutes' exposure is sufficient; but in dull weather, considerably longer time is required. With the electric arc-light, the time of exposure varies from twenty minutes to half an hour. The progress of actinic action on the Pellet paper may be tested by inserting several test-slips beneath a similar piece of tracing-paper, on which some lines have been drawn, withdrawing these slips at different periods during the exposure and inserting them in potassic ferrocyanide, until the exposure is found to be sufficient. By adopting this simple actinographic method, much disappointment may be prevented.

The paper sensitized by this process will keep for days after exposure before developing, so that when a considerable number of sun-copies are required, it is advisable to expose all of them when the light is good, and to develop them subsequently at leisure. The print should be transferred into a saturated solution of potassic ferrocyanide, not immersed, but floated with the prepared face next the solution. By simply turning up the edges of the print, the developing solution is prevented from reaching the back of the print. The development is rapid, one minute being generally sufficient. A blue coloration of the ground is a proof of insufficient exposure; while weakness of the lines indicates over-exposure. If the exposure has been sufficient, the paper may be left for a considerable time in the developing bath, to increase the definition of the lines. On the contrary, should the exposure have been weak, the print must be submitted for a short time only to the influence of the potassic ferrocyanide, to avoid blue spots caused by unreduced particles of iron.

After the completion of the development, the print should be floated face downwards upon clean water; and in about two minuter, it should be immersed in an acid bath, composed of eight parts of hydric chloride, three parts of hydric sulphate, and one hundred parts of water. From six to eight minutes is sufficient time to allow for the acid reaction on the iron compounds, and for the removal of the redundant iron compounds by the acid. The print should next be thoroughly washed with water, and dried. Any blue discoloration may be remedied by a dilute solution of potassic hydrate, applied with a quill-pen, or brush, and blotted.

The potash solution is composed of one part of potassic hydrate and twenty-eight parts of water. A solution, termed blue solving, is provided for making alterations, or additions, on paper prepared by this process.

[2] "Die Modernen Lichtpaus Verfahren, zur Herstellung exacter Copien nach Zeichnungen Stichen," etc.

When the helios produced by the Pellet process are discolored, they may be effectually bleached by a 4 per cent. solution of hydraulic sulphate in summer; and in winter this may be increased to 6 per cent.

When the cyanotype, the Pellet, or Shawcross prints are intended for the workshop, they should be saturated with white, hard varnish. This will prevent the penetration of oily matters, grease, etc., and the adhesion of dirt. For rough work, the prints should be mounted on linen, with fresh, white paste, entirely free from acid and alum, applied to the back of the print.

No. 4.—*Positive Cyanotype Process (Pizzighillis'. Dark blue lines on white ground).*—This process is very similar to Pellet's; the solution consists of five parts of powdered gum-arabic dissolved in 25 parts of water, and one part of ferric-ammonic citrate with two parts of water; and one part of ferric-chloride with two parts of water, mixed in the proportion of thirty parts of the first, eight of the second, and five of the last. At first the mixture is limpid, but it soon grows thicker. It should be applied to the paper immediately after mixing.

The exposure is the same as for Pellet prints.

The developing solution is composed of one part of potassic ferro-cynanide and five parts of water. This solution should be carefully applied to the face of the print with a large camel's-hair brush, when the delineations in dark blue will at once appear. As soon as the drawing is quite clear, the prints should be placed in a solution of twelve parts of hydric chloride and ten parts of water. The ground will then become quite clear and white, and the gum will be removed. The print should be finally washed in clean rain-water.

No. 5.—*Nigrographic Process (Black lines on a white ground).*—This process, although complicated, and requiring scrupulous care in manipulation, is worthy of a place, because of the peculiarity of the reagents used, and the method of operation.

The solution employed consists of twenty-five parts of gum-arabic, seven parts of potassic bichromate, one part of alcohol, and one-hundred parts of water. This solution should be applied to thoroughly sized paper, dried and kept in a dark place.

The exposure is the same as in the ferro-prussiate, or cyanotope processes. After exposure, it should be placed in cold water for twenty minutes, to wash out the unchanged bichromated gum. After drying, it should be treated with a mixture of five parts of sheilac one-hundred parts of alcohol,and fifteen parts of finely ground lampblack. This black mixture should be carefully applied, by means of a sponge, to the face of a print, which should then be immersed in an acid solution of one-hundred parts of water and three parts of hydric sulphate. The superfluous black color can be removed by a soft camel's hair brush; and the delineations appear in black lines on a white ground.

No. 6.—*Platinotype Process (Willis's. White lines on a black ground.)*—This process is based on the reducing action of a ferrous salt, when exposed to actinic light, on metallic chlorides, especially that of platin m.

The sensitizing solution is composed of 60 grains of potassic platinous chloride, 60 grains of ferric oxalate, and 1 ounce of water.

The proper time of exposure is about one-third of that required for the argentine-nitrate process. During the exposure, the initial yellow color of the sensitized paper becomes pale grayish brown, and finally of a dull orange hue. The last change indicates that the iron salt has been almost completely reduced. If the prints are not immediately developed, they should be preserved from moisture by being placed in cases in which there is a lid containing calcic chloride.

The print should be developed, in non-actinic light, in a solution of 130 grains of potassic oxalate and 1 ounce of water, at a temperature of from 150° to 200° F. The print should be floated in the developing solution for not less than four seconds, with the printed face next to the developing solution. As soon as the print has been properly developed in the above solution, it should be washed, either in one part of hydric chloride with sixty parts of water, or in ten parts of citric acid with one hundred part of water; the hydric chloride solution being the best. The The print should be washed in the dilute acid solution for about ten minutes, or until it does not communicate the slightest tinge of color to the bath: if it does, it should be reimmersed in the bath, or, better still, in a fresh-made dilute acid solution, which should remove all traces of iron salts from the paper. The prints should be finally washed in copious relays of clean water for at least fifteen minutes. This process is used by the Midland, and London and North-Western Railway Companies, upon the Ordnance Survey, and by the Royal Engineers, and gives most exquisite prints.

No. 7. *Gallic Acid Process (Shawcross's direct positive Black lines on white ground).*—This process is one of those now employed by the author; and by giving a direct positive black copy, has a considerable advantage over the other processes described. The re-agents employed are inexpensive; and the process is comparatively simple. A gallo-tannate of iron is formed by the combination of gallic or tannic acid with a ferric salt; and this latter salt on exposure to light, is converted into the ferrous state. The part of the paper preserved from light, not being changed by actinism into the ferrous state, is ready to combine immediately with the gallic acid on immersion in a suitable solvent such as water.

The sensitizing solution consists of one-hundred and fifty parts of gelatine, sixty parts of ferric sulphate, ninety-four parts of sodic chloride, 18.8 parts of hydrogen tartrate, one-hundred and fifty parts of ferric chloride, and one-hundred and ten parts of water. The solution should be uniformly spread over the surface of the paper by means of a roller pad, or flat brush (the roller pad being preferable), and the paper dried in the dark. It should then be dusted over with finely-powdered gallic or tannic acid; and the powder should then be thoroughly rubbed on the paper until it is brought into contact with every part of the sensitive surface; it is now ready for use.

As soon as the yellowish color of the paper is converted into white, the exposure is complete. The lines of the drawing will appear in the initial yellow color until the print is immersed in the developing bath of water, when the yellow lines will at once be converted into a dark color approaching to black. If exposed too long, the yellow lines of the drawing will entirely disappear. The prints should be thoroughly washed in two relays of water, the surface of the print being carefully rubbed over with a stiff brush while submerged in the water of the bath. The more thorough the washing, the better is the print; and although the print may appear white after the first washing, subsequent exposure to sunlight will probably show disagreeable discolorations in the white surface. Lines may be altered, or stains removed, by using a 1 per cent. solution of hydric sulphate. When a more rapidly sensitizing solution is required, either glucose or dextrine may be substituted for the gelatine, which will give a violet or purple hue to the reproduced lines on the sun-copy. Blue lines can be produced by substituting potassic ferrocyanide for the gallic acid; red lines by substituting potassic sulphocyanide for the gallic acid; and green lines with caoutchouc.

The author strongly recommends the use of this process, which is the invention of Mr. Shawcross, of the Water Engineer's Office, Liverpool; for it does not require an acid solution for development; the exposure may be determined by simple examination ;it gives a direct positive, and practically black copy; colored tracings may be reproduced, as it reproduces half tones; and the copy is in ink (gallo-tannate of iron), and is permanent.

No. 8. *Argentic Nitrate Process (White lines on a black ground, or vice versa).*—This process, although far more expensive than the other processes described, is advantageous when small, intricate, and delicate drawings require to be reproduced.

When organic matter, such as the albumen of albumenized paper, is brought into contact with a soluble salt of silver, a definite compound of argentic albuminate is formed, which on exposure to light becomes dark colored. It is inferred, from chemical considerations, that although the dark compound is not argentic oxide, yet the coloration is dependent on the formation of argentic oxide. Argentic albumniate is white, but becomes dark red-brick color in the presence of actinic light. If gelatine is used as the size instead of albumen, it combines with the silver, and on exposure to light assumes a red tint. If starch is used for the size, exposure to actinic light converts argentic starch compounds into a dark violet color.

The sensitizing solution consists of 60 grains of argentic nitrate, and 1 ounce of distilled water, with the addition of ten drops of a saturated solution of citric acid for each ounce of argentic nitrate. This solution should be poured into an earthenware bath for a depth of ½ inch, and is prepared by thoroughly mixing together 154.3 grains (10 grams) of ammonic chloride, 0.264 pint (15 c. cs.) of alcohol, and 2.37 pints (135 c. cs.) of water, and then gradually adding 8 pints (450 c. cs.) of albumen. Its application should be effected as follows:—The paper should be held by the two opposite corners, in such a way that it will first touch the surface of the solution on a line between the two corners not held by the hands. The two corners held in the hands are then dropped, first one and then the other. Any air-bubbles can be removed by gently moving the paper, while half is held out of the solution. If the edges of the paper curl away from the solution, they may be gently blown down to the surface. The paper should be gently drawn from the solution by the adjacent corners, so that it may be drained while it is lifted; and it should then be dried.

A few minutes exposure in sunlight is sufficient; and when the color of the print becomes a deep chocolate tint with metallic reflections, it is sufficiently exposed

After removal from the printing-frame, the print should be thoroughly washed in copious relays of water. The print may be toned in a solution of 1 grain of auric chloride, 30 grains of sodic acetate, and 10 ounces of water: and it should be allowed to remain in

this solution for fifteen minutes. After again washing in rain, or distilled water, the print should be immersed in a fixing solution of 4 ounces of sodic hyposulphite and 1 pint of water, for fifteen minutes, and afterwards thoroughly washed in several changes of water, or with a copious supply of water from an india-rubber tube.

No. 9.—*Uranium Salt Process* (*Brown or grey lines on a white ground.*)—This process is based upon the reduction of uranic nitrate to the uranous state in the presence of organic matter, such as the size contained in the paper, and under exposure to actinic light.

The sensitizing solution consists of 617.2 grains (40 grams) of uranic nitrate, and 4.4 pints (250 c.cs.) of distilled water. The paper should be floated, as in the argentic process, for about eight minutes, in a bath of the above solution, and after drying is ready for use.

The time of exposure required for this paper is rather longer than that required for the argentine process.

If a brown copy is required, the exposed side of the paper is floated for about five minutes, or until the details are completely visible, on a developing solution consisting of 15.43 grains (1 gram) of potassic ferricyanide, two drops of hydric nitrate, and 4.4 pints (250 c.cs of water; and the print should then be thoroughly washed in slightly acidulated water.

If grey lines are required the developing solution should be made with 30.86 grains (2 grams) of argentine nitrate, 3 or 4 drops of acetic acid, and 0.51 pint (40.c.cs of water. The print should be floated on this solution, when the delineation will rapidly become visible. If the lines are weak, they may be strengthened by adding a few drops of a saturated solution of gallic acid. The print, when fully developed, should be thoroughly washed in pure soft water free from carbonates or chlorides.

No. 10. *Gelatine Process* (*Poitevin's*).—This process is based on the peculiar property possessed by the ferric salt, of rendering gelatine insoluble, so long as it is not exposed to actinic rays.

The sensitizing solution is composed of ten parts of ferric chloride, 3 parts of hydrogen tartrate, and 100 parts of water. Before the paper is coated with the sensitizing solution, it should be floated on a 6 per cent. solution of gelatine while this is still warm, and with which is mixed any suitable pigment, of the desired color, such as lamp-black. When dry, it should be immersed in the sensitizing solution, and afterwards dried; and it is then ready for use. The paper should be sensitized and dried in non-actinic light.

The sensitized paper should be placed behind the tracing, or drawing, reversed as regards right and left. The time of exposure varies from half a minute to several hours, according to the intensity of the light and the thickness of the paper. The gelatine surface which is not covered by the lines of the drawing becomes soluble in hot water on exposure to the light.

After the paper is removed from the printing-frame, it should be immersed in water at a temperature of 80° Fahrenheit, when the soluble gelatine will run off the paper.

No. 11. *Ammonic Bichromate Process* (*Cros and Vergeraud's. Dark brown lines on a white ground.*—The theory of this ingenious process, communicated to the Academy of Sciences,[1] is probably as follows. The action of actinic light converts the bichromate, in the presence of organic matter, into chromium, and renders the organic matter insoluble. The ammonium is dissolved in the solvent; and the chromium, in the presence of argentic nitrate, becomes converted into argentic bichromate.

The sensitizing solution consists of 30.86 grains (2 grams) of ammonic bichromate, 231.48 grains (15 grams) of glucose, and 1,543.2 grains (100 grams) of water.

The time of exposure is similar to that of the Pellet process, and should be continued until the initial yellow color of the sensitized ground is converted into gray. The print should then be immersed in a solution consisting of ten parts of acetic acid, 88 parts of water, and one part of argentic nitrate. The lines will come out of a red color, which on drying, will become converted into dark red.

Printing on Fabrics.—The best description of textile fabrics for this purpose is fine linen, or the finer kinds of cotton fabrics (Nainsook, for example). When silk is used, the denser kinds of sarsanet, and the soft silks are the best.

To albuminize or size the fabric, it should be boiled in water made alkaline by the addition of a little potash and after drying, it should be coated with a sizing solution composed of 30.85 grains (2 grams) of ammonic chloride, 4.4 pints (250 c.cs.) of water, and the white of two eggs.

The sensitizing operations by the various processes can be performed as for paper, with the exception that, with the argentic nitrate process, 70 grains of argentic nitrate should be used instead of 60. The exposure and developing operations are the same as for paper, with the exception that, with the platinotype process, the acid solution should be composed of one part of hydric chloride and forty-five parts of water. The Platinotype Company prepares special solutions for the application of the platinotype process to fabrics. If treated with the platinotype solution, the printed fabric can, according to Mr. Willis, be washed when soiled without injury to the image.

Fabrics should be sensitized in non-actinic light, or by gas or lamplight. A good method is to lay the fabric on a glass plate, and apply the sensitizing solution by means of a sponge until the fabric is thoroughly saturated. The material should then be carefully dried, by gently waving it backwards and forwards before a stove until it is quite dry. The fabric should not be brought nearer than 2 feet from the drying-stove, otherwise the sensitizing solution will undergo decomposition. After sensitizing, the fabrics should be preserved from damp.

No. 12.—*Zincographic Process.*—This process is used in some of the continental drawing-offices, amongst others, that of the Belgian department of the Ponts et Chaussées. It has this advantage over the other processes described, that when once a zincograph copy has been obtained, any number of duplicates can be reproduced by sending the copy to a lithographic copperplate printer.

Asphaltum, or bitumen, is the sensitive agent, and was discovered by Niépce de St. Victor. Its application for the production of photographic images was the forerunner of the invention, by his coadjutor Daguerre, of using the iodide of silver as the sensitive agent. Asphaltum, when exposed to light, becomes insoluble to ordinary solvents; so that when it is exposed under a tracing, the opaque lines of the drawing prevent the asphaltum from becoming insoluble. The best asphaltum for this purpose is that obtained from the shores of the Dead Sea in Syria, and is commonly known as Jew's pitch; but it is also obtained from the islands of Cuba and Trinidad. To prepare the asphaltum for use, it should be dissolved in turpentine or benzole, quite free from water; and to this should be added 10 per cent. of oil of lemons. The quantity of asphaltum should not exceed 5 per cent. of the benzole. Only sufficient solution should be prepared to serve for immediate use; and the sensitizing solution should be prepared in non-actinic light, and allowed to settle. A zinc plate should be used of the same size as the tracing to be reproduced, and should be evenly covered with a film, of the sensitizing solution. In order to obtain a perfectly even film, the plates should be placed on a horizontal table or board, which can be quickly turned or spun round by hand. As soon as the sensitizing film is even and uniform, it should be allowed to dry; and if turpentine has been used to dissolve the alphaltum, this will take an hour, or perhaps more; if benzole is used, it will dry far more quickly; and the drying operation can be controlled by the use of oil of lemons, etc.

The tracing, reversed as regards left to right, should be placed in the printing-frame; and the zinc plate should be placed with its sensitizing surface next to the tracing, and clamped down or otherwise pressed to it. To prevent the adhesion of the sensitized surface to that of the tracings, the former should be rubbed over with powdered French chalk. The time of exposure varies with the degree of intensity of the light, and the thickness of the asphaltum film; but in sunlight, thirty minutes at least are required, even with the thinnest films. Longer periods, varying from two hours to twenty-four hours, are needed for thicker films. By using an actinograph, similar to the method recommended for the other processes, the progress can be watched. A small piece of zinc, covered with the same solution of as near as possible the same thickness, should be applied under identical conditions. If by rubbing it with a piece of cotton-waste dipped in turpentine or benzole, the cotton becomes discolored, the exposure is not complete. The edge of the zinc plate can also be tested in the same way.

The plate should be developed by the aid of a ruby lantern. The development is effected by gently rubbing over the sensitized surface with a tuft of cotton dipped in olive oil. After the expiration of a few minutes, it should be gently rubbed over with turpentine. The image will gradually appear; and the alternate process of rubbing with oil and turpentine should be continued until the soluble parts are cleaned. The plate should then be washed with soap and water, and finally washed in a copious supply of clean water, and then dried, after absorbing the water with blotting-paper.

Another method consists in filling a bath with turpentine, and immersing the plate therein, gently rocking the plate until the soluble parts of the asphaltum are washed off; but care must be taken not to allow the turpentine to dissolve the parts which should be insoluble. The plate should be finally rinsed with clean turpentine, and then washed with water until the soluble parts are cleared off, and lastly dried. This immersion operation requires more care than the rubbing method, but it is more rapid. A solution of nitric acid, made by adding to it twice its volume of water should then be applied, either with a quill or a tuft of cotton waste, to the exposed parts of the zinc plate, until it is sufficiently etched for printing by a copperplate printer.

In the preparation of asphaltum it is found that a greater degree of sensitiveness and sharpness of definition is effected by adopting the following process. The asphaltum is dissolved in rectified oil of turpentine until the solution attains a syrupy consistency. After resting a few days, ether is added to the solution to the extent of three to four volumes, and two days subsequently the resulting precipitate is removed and washed with ether and dried; it is then redissolved in pure benzole, to which 1.5 per cent. of Venice turpentine is added to produce a more flexible coating and it is then ready for use. The exposure and the development are the same as for the asphaltum prepared in the ordinary manner.

[1]Comptes Rendus Hebdomadaires des Seances. 1883. Tome 96, page 254.

ACCIDENTS IN MINES.*

VIII.

Fire-Damp Indicators.

(*Continued from page 327.*)

We have repeatedly tested Mr. Liveing's indicator with mixtures of air and marsh gas, in which the gas was present in known percentages (up to about 3 per cent.) of the volume of the mixture, and we found that the instrument gave very accurate determinations of the composition of the mixture.

Mr. Liveing's indicator is graduated to show directly the percentage of gas in the air, but the scale is divided on the hypothesis that the two spirals in pure air are rendered equally brilliant by the same current. This condition may be fulfilled when the spirals are first introduced, but after a comparatively short period of use, as one wire will in general be more heated than the other, the wires will be permanently altered in different degrees, and they will cease to be equally brilliant in air. The scale divisions will then cease to indicate correctly the percentage of gas present in the atmosphere tested.

In the instrument submitted to us the scale admits of being shifted to a slight extent, so that the zero can be made to coincide with the line of junction of the screens when they are equally illumined by the spirals in pure air. With the scale thus adjusted the divisions indicate percentages of gas, which, though not strictly accurate, are sufficiently correct for all practical purposes. When the spirals become so much altered by constant use that the adjustment of the zero is impossible with the range of motion allowed to the scale, two new spirals must be introduced into the instrument. If the indicator is required to give, for any special purpose, strictly accurate results, some other mode of adjustment must be adopted. One of the wires might be arranged to admit of alteration, so that the two may be always made to be equally brilliant in air; the scale would then be fixed in the instrument. Or the percentage scale might be used in a manner which allows the adjustment of the zero to be effected, by preliminary observations when both spirals are in pure air, but which does not alter the value of the scale divisions.

If the scale, fixed as in the existing instrument, be graduated as in an ordinary photometer, so as to indicate the ratio of the brilliances of the two wires, any relative alteration in these will only introduce the necessity for a simple calculation. If x be the ratio of the brilliancy of the exposed wire to that of the protected wire when both are in air, and y the corresponding ratio when marsh gas is in the atmosphere surrounding the exposed wire, then $\frac{y}{x}$ is the ratio of the brilliancy of the exposed wire in the gas-mixture to its brilliancy

*From "Final Report of Her Majesty's Commissioners appointed to inquire into Accidents in Mines, etc." 1886.

in pure air. This last ratio depends only on the percentage of marsh gas present in the atmosphere, and it being thus determined, a reference to a table or diagram constructed from previous experiments will give the value of this percentage.

For the purpose of the inspection of a mine before workmen are allowed to enter, Mr. Liveing's indicator can be employed in a very simple manner. The instrument having been adjusted by experiments in air above ground, is delivered to the fireman with the screen fixed in a position corresponding to a perfectly safe percentage of fire-damp in the atmosphere. The fireman in going his rounds will then only have to fill the instrument with the air from any place, which he would under existing arrangements test with a lamp, and turn the handle until the wires are at a bright red heat. If the face of the screen towards the exposed wire is less strongly illumined than the other face, the place is fit for workmen to enter; if the former face is more strongly illumined than the latter, the place must be cleared by additional ventilation before the men are allowed to commence work in it. A similar method may be adopted, though possibly with the instrument set for a smaller proportion of gas, in examining the neighborhood of a shot before firing it.

Mr. Aitken proposes to pass a current of the atmosphere of the mine, drawn from any place requiring examination, through a tube which contains two thermometers, one with its bulb uncovered, the other with its bulb covered with a mixture of platinum-black, or other catalytic substance, with plaster of Paris. If the atmosphere contains marsh gas, this coating on the bulb becomes heated, by the combustion of the gas, to a temperature above that of the entering gas-mixture. This additional heat, being partly communicated to the bulb, causes a higher temperature to be attained by the coated thermometer than by the one which has its bulb uncovered. The difference of temperature indicated by the two thermometers depends upon the proportion of marsh gas present in the atmosphere, and if it could be shown that, with a given pair of thermometers, it depends only on this proportion, it would of course be possible to arrive at the percentage of gas, by comparing the difference in the readings of the two thermometers with a table, formed from previous experiments with mixtures of marsh gas and air in known proportions.

Mr. Aitken states that he was able, with an instrument of this description, to detect the presence of air of very small quantities of illuminating gas, of artificially prepared marsh gas, and of other hydro-carbon gases, but that natural fire-damp gave unsatisfactory results. He found it, moreover, necessary to raise the gas-mixture, before passing it over the thermometers, to the temperature of boiling water, and this circumstance would render his indicator very inconvenient for actual use in mines.

Dr. Angus Smith has proposed to use, for detecting the presence of fire-damp, an instrument known as a compression-syringe; a glass tube closed at one end and fitted with an air-tight piston. The tube is filled with the air of the mine, which is then rapidly compressed by the piston, and becomes in consequence more or less heated. If not less than 5 per cent. of marsh gas be present in the air, the rise of temperature is in general sufficient to bring about the combustion of the gas, and a flash is seen in the tube. By placing a small quantity of platinum-black at the closed end of the tube a flash may be produced by a smaller percentage of marsh gas, but no flash occurs when the air contains less than 2.5 per cent. of the gas.

As this instrument does not detect smaller percentages of gas than can be found by a safety lamp in moderately skillful hands, and, as, moreover, in mixtures of air and gas which are explosive, it is very liable to be broken by the violent concussion produced inside the tube, its use is not attended with any advantage and may lead to additional danger.

When pure air is enclosed in a vessel partly composed of some porous substance, such as bladder, india-rubber, or unglazed earthenware, and this vessel is surrounded by a mixture of air and marsh gas at the same pressure as the air inside the vessel, the gas diffuses through the porous substance more rapidly than air. The result is that the volume of gas which passes into the vessel is greater than the volume of air which leaves it in a given time, and consequently the pressure in the vessel in temporarily increased.

The increase of pressure in the vessel depends upon and is approximately proportional to the percentage of marsh gas in the atmosphere surrounding it, so that by observing the maximum pressure attained in the vessel, and by comparing it with that which arises when the surrounding atmosphere contains a known percentage of marsh gas it is possible to infer the per-centage of this gas present in the atmosphere at the time of the observation.

If the atmosphere surrounding the vessel contains carbonic acid gas instead of marsh-gas, the effect of diffusion is to temporarily diminish the pressure inside the vessel.

The indicators of Ansell and of Libin are designed to use this property of gases in order to detect their presence in the air of a mine.

Ansell has proposed various methods of rendering the increase or pressure in the vessel apparent, which are described in his patent. In one form of the instrument the vessel consists simply of an indiarubber balloon, which distends when the pressure increases inside; it is so arranged that when the atmosphere contains a certain per-centage of marsh gas the distention of the balloon closes a circuit, in which are included an electric battery and a bell. The ringing of the bell thus announces that the percentage of gas, for which the instrument has been adjusted, is attained in the surrounding atmosphere.

In other forms of the indicator the vessel is composed partly of glass or metal and partly of porous earthenware, and the increase of pressure is shown by a siphon-gauge, one leg of which is in communication with the inside of the vessel and the other with the surrounding atmosphere.

A very portable instrument consists of an aneroid barometer enclosed in a small cylindrical box, one end of which consists of a plate of porous earthenware. The dial may be arranged to show directly the percentage of marsh gas in the atmosphere, supposing no other gas to be present.

In Libin's indicator the vessel is composed partly of a cylinder of porous earthenware and partly of an elastic membrane. The distention of the latter by increased pressure in the vessel closes an electric circuit and causes a bell to ring.

Some of these instruments have been exhibited to us, which, when placed in a receiver containing a mixture of air and illuminating gas, rapidly detected the presence of the latter. In these experiments the percentage of gas in the mixture was considerable, but there seems no reason to doubt that instruments of this class are capable, under favorable conditions, of affording evidence of the presence of gas, when it bears only a small proportion to the air with which it is mixed. These instruments have, however, the following defects, which render them untrustworthy as means for examining the air of a mine:—

1. Changes of pressure and temperature will produce indications of the same kind as those due to gas.

2. If it is certain that, at the commencement of an observation, the indicator is filled with pure air at the same temperature and pressure as the atmosphere of the mine, gases other than marsh gas, if present in this atmosphere, will also produce changes of pressure in the instrument, and there is no means of determining how much of the total change of pressure observed is due to marsh gas. Thus aqueous vapor will produce indications which may be mistaken for those of marsh gas, while carbonic acid, acting on the gauge in the opposite direction to marsh gas, that is, producing a diminished pressure in the instrument, will mask to a certain extent the presence of the latter gas.

3. These instruments will only operate properly if they are suddenly exposed, while full of pure air, to a vitiated atmosphere, since their action entirely depends upon the difference in the composition of the gas-mixtures on the two sides of the porous diaphragm.

Suppose one of these indicators to be carried through the workings of a mine, and, neglecting all disturbances from changes of pressure and temperature and the presence of aqueous vapor, carbonic acid, etc., suppose that a place is reached where the atmosphere contains 1 per cent. of marsh gas. This will produce a small increase of pressure in the instrument which may be detected by the gauge, but the air on both sides of the porous partition will speedily become similarly mixed with gas; the instrument will become filled with a mixture of air and marsh gas containing 1 per cent. of the latter, and all indications of increase of pressure in the instrument will disappear. On continuing the tour of inspection air vitiated with 2 per cent. of gas may be encountered, but this will only produce an indication which answers to 1 per cent. of gas, and which will in time disappear, the instrument being eventually filled with a mixture of air and marsh gas containing 2 per cent. of the latter. It is obvious that the same process may go on, and the result may be that the instrument, when it arrives in an absolutely explosive mixture of air and marsh gas, will only indicate the presence of a very small percentage of the gas.

If indicators of this class are to be relied upon for the examination of the air in mines, a supply of pure air must be carried by the person making the inspection, and the instrument must be filled with it at each place of observation. This could no doubt be done, but the air would almost necessarily be carried in a compressed state, and then care would have to be taken, that the air introduced into the chamber of the indicator should be at the same pressure and temperature as the atmosphere of the mine. When, however, all these precautions had been taken, the presence of aqueous vapor and carbonic acid would still affect the indications of the instrument, and render the estimate of the quantity of marsh gas in the air uncertain.

As the density of marsh gas is less than that of air at the same temperature and pressure, the weight of a given volume of a mixture of this gas and air depends upon the ratio between their volumes; but the apparent weight of a body surrounded by an atmosphere is equal to its true weight diminished by the weight of the atmosphere which is displaced by it. Hence the apparent weight of a body in a mixture of marsh gas and air will, under given circumstances as to temperature and pressure, depend upon the relative volume of air and gas in the mixture, and it is possible by observing the apparent weights of

body in air, in marsh gas and in a mixture f air and marsh gas to determine the perentage of marsh gas in the mixture.

Proposals for employing this buoyant effect of the atmosphere in a mine on a body suspended in it as the means of determining the proportion of fire-damp which it contains, have been made to us by Mr. Henry Reece, Mr. George Duggan, and Messrs. T. and W. Chaloner and J. Della Bella. The two former have merely suggested forms which an apparatus for this purpose might take, but the instruments as sketched out by them would not be portable. Mr. Duggan, indeed, seems to intend that his indicator should be fixed in some place in a mine, and by causing an electric bell to ring, should give notice when a dangerous amount of gas is present.

Messrs. Chaloner and Della Bella have, however, exhibited to us an indicator constructed on their plan, which is easily portable and sufficiently delicate to detect small variations in the density of the atmosphere.

In this indicator a balance beam is formed of a solid ball and a hollow sphere rigidly connected by a rod, and it is made capable of turning with very slight friction round accurately constructed dead centers supported on a stand. The axis formed by the dead centers passes very near the center of gravity of the beam, and the weight of the beam is balanced by the upward force exerted by the atmosphere, which is equal to the weight of the air or gas-mixture displaced; this force acts vertically through the point which would be the center of gravity of the beam, if the ball, the rod, and the sphere were all solid and homogeneous.

A pointer attached to the beam moves over a graduated arc, and shows by its position on this arc in each case the position of equilibrium of the beam, thus indicating the weight of the displaced atmosphere from which it is intended that the extent of its contamination by marsh gas shall be inferred. The whole apparatus is enclosed in a case to protect it from dust and air-currents.

If marsh gas were the only gas mixed with the air, and if changes of temperature and pressure could be either avoided or rendered inoperative, this indicator would give accurate information as to the percentage of gas present in the atmosphere, but as the air of a mine is subject to great changes in temperature and pressure, and is liable to contain not only marsh gas, but carbonic acid and other gases as well as aqueous vapor, the instrument ceases to be practically useful. Several other instruments would be required in order that a correct conclusion as to the state of the atmosphere could be arrived at from observations with an indicator of this type.

Thus, the index of such an instrument having pointed to zero on this scale when it was surrounded by pure and dry air at a time when the height of the barometer was 780° m. m. (30.71 inches), if a certain deflection of the index is observed, this may be due to (1) the introduction into the air of 1 per cent. by volume of marsh gas; (2) the introduction into the air of 1.18 per cent. by volume of aqueous vapor; (3) a simple rise of temperature of 1.24° C. (2.23 F.); (4) a fall of 3.49 m. m. (0.37 inches) in the height of the barometer. It would be impossible to refer the deflection to its real cause without the aid of a barometer, a thermometer, and a hygrometer.

If one of these instruments is adjusted to have its index pointing to zero at the bottom of a downcast shaft where the height of the barometer is 780 m.m. (30.71 inches), and the temperature is 10° C. (50° F.), and if it be then taken into the return current at a place where the barometer stands at 775 m.m. (30.51 inches), and the temperature is 20° C. (68° F.), the index will be deflected to a certain extent, the return-air being as pure as the intake. If, however, this deflection be taken to denote the presence of marsh gas in the return air, instead of being referred to the above changes of temperature and pressure alone, it will lead to the conclusion that this air contains 8.94 per cent. by volume of the gas. The change of pressure here assumed would be indicated by a difference of level of 68 m.m. (2.7 inches) in a water gauge fixed in separation doors between the two places of observation.

With instruments of this type, percentages of marsh gas and carbonic acid in the proportion of 100 to 86 will completely mask one another, that is, an atmosphere containing 10 per cent. by volume of marsh gas and 8.6 per cent. of carbonic acid cannot be distinguished from pure air.

These instances will show that indicators based on the principle of weighing a volume of the atmosphere, or on the buoyancy of the atmosphere, are quite useless for the purposes of the general inspection of a mine.

Mr. H. G. Carleton has quite recently communicated to us a most ingenious plan for enabling a person in an office above ground to determine with considerable accuracy the density of the air at selected places in a mine by observations of its buoyancy.

This proposal requires that a delicate balance should be fixed at each of the places to be examined and that all these balances should be maintained in electrical communication with a balance in the office. It is not, however, practicable to carry this plan into execution; to preserve in a mine a number of delicate instruments safe from injury and even disturbance, and to secure that the cases enclosing them should allow the air to enter freely but should exclude all dust, would present almost insuperable difficulties. Moreover, in order that the indications transmitted to the balance above ground would be of any value from the point of view of the safety of the mine, it would be necessary, as Mr. Carleton points out, that the air in entering the balance cases in the mine should be freed, by absorbing materials, from aqueous vapor and carbonic acid; this, even with constant supervision, would probably be but imperfectly effected, and the indications would consequently be misleading.

Professor George Forbes has proposed to determine the percentage of fire-damp in the atmosphere by observing the length of a tube, containing the air to be tested, which gives the maximum resonance, when a tuning fork of given pitch is set in vibration near its open end.

His indicator consists of a brass tube 1 inch in diameter and between 6 and 7 inches long, in which a tightly fitting piston can be moved by means of a rack and pinion. The pinion head, a disc 3 inches in diameter, is graduated, and turns under an index attached to the tube; one complete revolution of the head moves the piston through 1 inch. In front of the open end of the tube is fixed a tuning fork capable of vibrating 512 times per second.

The tube is first filled with pure air and, the tuning fork being set in vibration, the piston is moved backwards and forwards until position is found which gives the most intense resonance. Either the reading of the graduated disc is now recorded, or the disc is turned on the pinion until the index points to zero, and it is then firmly secured to the pinion. This adjustment having been made, the tube is filled from the atmosphere to be tested, and the position of the piston which gives the strongest resonance is again found; the reading of the graduated disc now shows the increase or decrease of the distance of the piston from the open end of the tube; from this, if the temperature is unchanged and the atmosphere only contains marsh-gas, the percentage of gas present may be inferred.

A thermometer is attached to the instrument, and either a correction is applied to the observed reading to allow for changes of temperature, or the value of the scale, expressed in percentages of gas, is recorded for different temperatures in a table prepared from preliminary experiments with gas mixtures of known composition.

The exact observation of the position of the piston, which produces the strongest resonance, is a matter of some difficulty, requiring a trained and sensitive ear. To remove this difficulty an instrument has been devised by Messrs. Forbes and Blaikley, with the view of making it possible to determine the composition of the atmosphere from observations of the beats produced by two sounds nearly in unison. This ingenious instrument depends for its action on the fact that if a free reed be fixed at the otherwise closed end of a tube, the vibration of the reed is to a certain extent controlled by the column of air or gas in the tube. If the tube be of such a length that the vibrations of the column of air in the tube synchronize with the natural vibrations of the reed, then the combination gives the proper sound due to the reed, but if the length of the tube, or the density of the contained gas, be changed, the reed and gas column adapt themselves to one another to a certain extent, and a sound is produced which differs in pitch from that of the natural note of the reed.

(TO BE CONTINUED.)

The Louisville and New Albany Bridge.*

BY T. C. CLARKE AND C. MACDONALD.

(*Illustrated.*)

The bridge recently completed over the Ohio river, connecting the cities of Louisville, Kentucky, and New Albany, Indiana, illustrates the efficiency of the cantilever system of construction, in cases where the difficulties incident to erection are excessive. The present paper is confined to a description of the superstructure only, with particular reference to such portions as involve comparatively novel features of design, and also some details as to the method of erection. The structure consists of two main cantilever spans, respectively 480 feet and 483 feet long, center to center of piers, and separated by a continuous span of 360 feet; two anchor spans, 260 feet each; a swinging span, 370 feet, and a fixed span on the New Albany end, 240 feet long; making a total length of 2,453 feet between centers of abutment cylinders. The 483 feet span crosses what is known as the "canal channel," between Sand Island and the Kentucky shore at a point about 1,000 feet below the entrance lock. The current of the river in this channel is at an angle of 60° with the axis of the bridge; and it was thought necessary to construct the piers with both faces parallel to this direction, thereby involving considerable complication of detail in passing from the square connections of the adjoining spans to the skew piers of the 483 feet span. At the ordinary stage of the water, all river traffic passes under this span, the clear distance from the under side of trusses to the water being 95 feet. At high water the traffic passes under the 480-foot span on the opposite side of Sand Island; and at extreme high water, when there is not sufficient clearance, the swinging span is available.

* Read before the British Association for the Advancement of Science at Birmingham, 1886.

The 360-foot span is 65 feet in height throughout; projecting 160 feet beyond the supports at either end, with inclined top chords, to the point of connection with the suspended trusses. The anchor spans are 65 feet high at towers and 23 feet high at the top of the inclined end posts, and project 160 feet, with inclined top chords, to the connection with the suspended trusses. The suspended trusses are 160 feet long, 28 feet high, and have parallel chords. The general sky line of the cantilever system is thus made to conform to the requirement of the greatest economy of material consistent with the specified strength. The cross-section throughout the main system, shows a width of 24 feet 6 inches between centers of trusses, within which the railway track and side walks are laid; and at either side, projecting brackets for the roadways; making total width from out to out 49 feet.

In the chords, where tension strains alone exist, eye bars are used, connected by pins. Where strains of tension and compression alternate, or compression alone exists, the sections are trough shaped, and composed of plates and angles, faced square at splices. Steel is used in the top and bottom chords, end braces, pins, bearing plates, and rollers. The floor consists of wrought-iron cross-beams suspended from the pins at panel points, by yokes; wrought-iron track stringers for the railway track, placed 10 feet apart, with cross-ties of yellow pine, 8 inches wide by ten inches deep, spaced 16 inches between centers; also guard rails of yellow pine. The roadways and side walks consist of 7 inches by 16 inches yellow pine stringers spaced 2 feet apart, upon which rest lower floor of roadway, 3-inch oak laid diagonally; upper floor of roadway, 2-inch yellow pine; floor of side walk, 2-inch yellow pine. The outer ends of the cross-beams are connected by a substantial wooden hand railing; and wooden screen separate the railway from the road traffic.

The steel used was manufactured by the open hearth process. For compression members, sample bars ¾ inches in diameter taken from every heat were required to bend 180° around same diameter, to show an elastic limit of not less than 50,000 pounds per square inch, an ultimate strength of not less than 80,000 pounds, an elongation of 15 per cent. in 8 inches, and a reduction of area at point of fracture of 35 per cent. Chemical tests showed a range of carbon between $\frac{34}{100}$ths and $\frac{42}{100}$ths of 1 per cent. and less than $\frac{1}{10}$th of 1 per cent. of phosphorus. The steel for eye bars and rivets contained not more than $\frac{33}{100}$ths of 1 per cent. of carbon, and less than $\frac{1}{10}$th of 1 per cent. phosphorus. ¾-inch sample bars from each heat bent cold 180 degrees and set back under a hammer without flaw. They were required to shown an elastic limit of not less than 40,000 pounds per square inch, an ultimate strength of 70,000 pounds, an elongation of 81 per cent. in 8 inches, and a reduction of area of 42 per cent. Full sized bars were allowed an elastic limit of 35,000 pounds and an ultimate strength of 65,000 pounds.

All steel connected by rivets was first punched, and, after assembling, the holes were reamed ⅛ inch larger before riveting. Eye bars were made by upsetting the ends and forging to shape of eye. After the blacksmith work was finished the bars were annealed, at dark red heat throughout their entire length, and then bored to exact centers, the holes having $\frac{1}{50}$ of an inch clearance over diameter of pins. The wrought-iron used in shapes and plates, as in the floor system, was required to show an elastic limit of standard sample bar of 24,000 pounds per square inch, an ultimate strength of 47,000 pounds, an elongation of 10 per cent., and a reduction of area of 15 per cent. In plates exceeding 30 inches in width, an elongation of 8 per cent. and a reduction of 12 per cent. was considered satisfactory.

The structure is proportioned to carry, in addition to its own weight, the following moving loads: For railway traffic, a train of freight cars weighing 2,340 pounds per foot, drawn by two "Consolidation" locomotives, weighing 57 tons of 2,000 pounds each, with tenders weighing, when loaded, 32 tons of 2,000 pounds each. To provide for impact, all such parts of the structure as are liable to sudden strains were calculated, with additions to the above specified rolling load, as follows: Floor beam hangers and riveted connections of stringers and floor beams, 100 per cent.; floor beam vertical suspenders, over 15 feet long, 50 per cent.; floor beams, stringers, and members subjected to counter strains, 25 per cent. The permissible working stress in the several members was determined by Launhardt's formula, as follows:

$$\text{Stress per sq. inch} = U \times \left\{ 1 \div \frac{\text{minimum stress}}{2 \text{ maximum stress}} \right\}$$

in which U equals 13,000 pounds for steel in compression, and 14,000 pounds for steel in tension; for iron in compression, 7,500 pounds; and for iron in tension (plates and angles), 8,500 pounds. The working stress above given was reduced for columns in proportion to the ratio of length to the least radius of gyration of the section. Wind strains are proportioned to resist a force at right angles to the axis of the bridge equivalent to 450 pounds per foot of span upon the bottom lateral system, and 150 pounds per foot on the top lateral system. Permissable working strains in the laterals were taken at 50 per cent. greater than the values determined by Launhardt, as above:

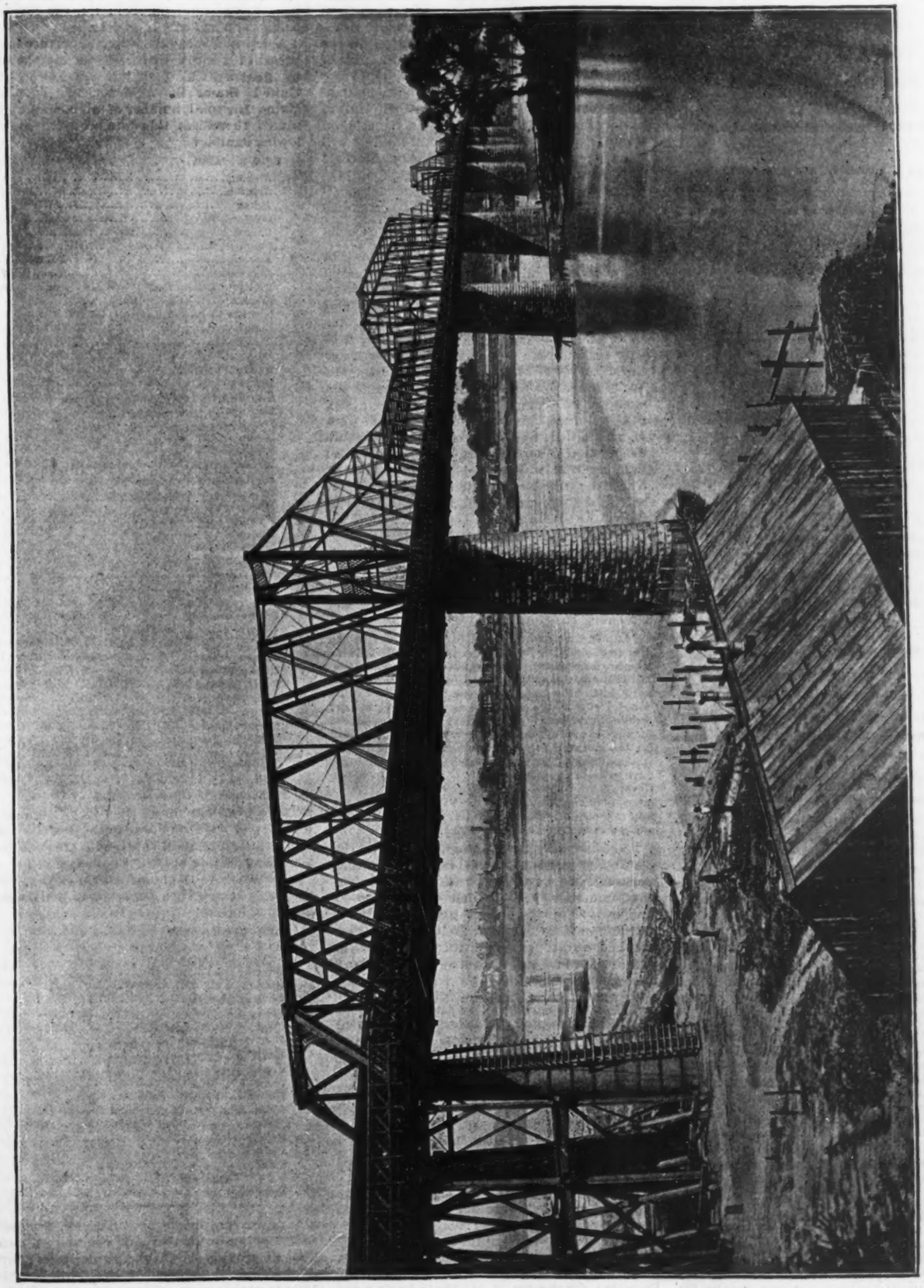
The chief interest connected with the work centers in the circumstances under which the erection was effected. The Ohio river is subject to extraordinary floods, particularly in winter, at which time very considerable quantities of ice and drift wood are carried down by a current exceeding six miles an hour, which nothing in the form of false works could be expected to resist. Upon one occasion, during the erection of the canal span, the river rose 57 feet in six days; while several times floods of 25 feet to 35 feet occurred. Again, it was a prime condition that false works should not be placed in the canal channel, for fear of obstructing navigation. These conditions render it necessary to reduce the risk from loss of false works to a minimum; and the cantilever system of construction at once suggested itself as the most feasible solution of the problem. The position of Sand Island is such that it afforded protection to the false works under the 360-foot span, and there remained therefore but one span, the 260 foot anchor span, on the Indiana end, about which there could be any question. It was believed that this could have been erected before the February flood of the year, but delays in obtaining material threw this work into the worst season of the year; and at one time, when the floor system had been placed in position preparatory to the erection of the trusses, the water rose 32 feet in four days, and lodged a mass of drift against the trestles to a distance of 75 feet up stream. The heavy weight of the iron on top of the false works proved sufficient, however, to hold them in place till the danger was over, and the erection of the trusses proceeded without further delay.

Erection began in the spring of 1885, on the 360-foot span, and every preparation was made to complete all the critical portions of the work before the end of that year; but, owing to unexpected difficulties in getting steel of the proper quality, and in sufficient quantity, the first span was not completed until November 28, 1885. In the meantime, the outdoor force was worked to great disadvantage, and a correspondingly increased expense was involved. It was a frequent occurrence that material arrived on the ground in the morning, and in three hours was lifted into position. A wooden traveler was used in this span, designed to do duty as a projecting derrick for the erection of the cantilever arms at each end. It was composed of a Howe truss span 110 feet long, 20 feet high, and 20 feet outside width. Upon the top of this, trestle bends, 50 feet high, were secured, to form a staging for the erection of the upper chords. The whole frame was then rolled forward on 6-inch wooden rollers, placed at intervals of 20 feet under the bottom chord. The entire weight of the traveler and hoisting engine was 140,000 pounds.

The suspended trusses were erected as continuations of the 160 feet cantilever arms, due provision being made for erection strains. An adjustment was provided at the junction of the top and bottom chords of the suspended span with the arms, by which a difference in length of 2 inches between centers of piers could be provided for. This made it possible to construct all the parts of the center span in exact accordance with the calculated dimensions, including the closing sections of chords, and to place the same in position without reference to temperature. The plan pursued was to draw the top chords back on each half span by screwing down the upper set of wedges until the center sections of the top chord could be set in place. In the same matter the bottom chord links were adjusted to permit the driving of the center pin, after which the wedges above and below were removed, and the entire span rested upon its duly provided supports. The total weight of metal in the entire bridge is 6,000,000 pounds or at the rate of 2,446 pounds per lineal foot.

On the 15th of June last, a series of tests were made under the direction of Mr. John MacLeod, Chief Engineer of the Bridge Company. The central deflection of the 480-foot span, when loaded with two engines in the center and loaded cars on the remainder of the span, and with wagon ways both loaded, was 5¼ inches. At the same there there was an upward movement of 1 inch at the center of the anchor span. No observation was taken on the 360-foot span for this position of load. During the continuance of the tests, the rigidity of the structure was demonstrated to the satisfaction of the engineers, and the bridge was thrown open to the public. The structure above described was built by the Union Bridge Company, of New York, for the Kentucky and Indiana Bridge Company of Louisville, Kentucky. The work was done under the supervision of Mr. John MacLeod, Chief engineer, Mem. Am. Soc. of C. E.

It is found that walls laid up of good, hard-burned bricks, in mortar composed of good lime and sharp sand, will resist a pressure of 1,500 pounds per square inch, or 216,000 pounds per square foot, at which figures it would require 1,600 feet height of 12-inch wall to crush the bottom courses, allowing 135 pounds as the weight of each cubic foot. It also appears from accurate calculations and measurements that walls laid up in the same quality of brick and mortar, with one-third quantity of Portland cement added to the same, are capable of resisting some 2,500 pounds per square inch, or 360,000 pounds per square foot; this would require a height of wall 2,700 feet to crush the bottom bricks.



THE LOUISVILLE AND NEW ALBANY BRIDGE. (*See Description on Page 341*).

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

VOL. XVI. Saturday, November 27, 1886.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

PHILADELPHIA OFFICE.
504 WALNUT ST.
W. M. PATTON, Manager.

Authorized representative for Pennsylvania, New Jersey and Delaware. Advertising rates made known on application.

CHICAGO OFFICE.
115 DEARBORN ST., ROOM 85,
EDWARD EDGERTON, Manager.

TERMS OF SUBSCRIPTION.

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One Year	$5.00
Six Months	2.50
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MAGAZINE RENEWALS.

The *Century Magazine* closes its yearly volume with the *October Number*. Renewals are in order for November. The price to ENGINEERING NEWS subscribers and their friends is $3.55; with ENGINEERING NEWS, $8.55. The new *Scribner's Magazine* will be out December 1. Price $3.50 to our subscribers. *Harper's Monthly* is renewable on December 1. Orders ought to be sent in in November to save the publishers trouble.

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THE members of the Polytechnic Association of the American Institute, in accordance with a desire expressed by gentlemen well known in engineering circles, propose to reorganize the Polytechnic Association on the same general plan as the Franklin Institute of Philadelphia.

The plan, as at present outlined, contemplates semi-monthly meetings in their Hall in Astor Place; at these meetings a paper upon some practical subject of general interest will be read and discussed, new and meritorious inventions exhibited, reports read upon progress in science and the arts since last meeting, and the reading and answers to questions deposited in a "question-box" since last meeting.

To these it is proposed to add a course of lectures by eminent gentlemen, increased library and reading-room facilities and an improvement in the collection of models and working drawings. The present library has in it 15,000 volumes. The full privileges of this Institute can be secured by paying $10.00 initiation and $5.00 annual dues; after ten years annual payment an annual member become a life member and all dues cease. Fuller information can be obtained from D. R. Garden, Secretary of the Polytechnic Association, Astor Place, New York. The first meeting will be held on December 9, when the President, Robt. Grimshaw, M. E., will read a paper on "The Practical Application of the Steam Engine Indicator."

"A Humiliating State of Things."

Mr. John Ward, shipbuilder on the Clyde, says in the course of a lecture before the Greenock Institute:

"I find a circular advertised in this country by the United States Navy Department, asking for designs for an armored cruiser or armored battle ship. The terms of the circular show that the United States Government wished the designs to come from those in this country who, at the country's expense, have similar designs to get out for our own Navy. The sum offered for the *betrayal of trust* was $15,000, with a further sum for the working drawings here. It is a humiliating state of things, first, that a foreign Government should have cause to know the efficacy of a bribe upon our Government officials; second, that a friendly Government should not scruple to lay such temptation in the way of weak patriots. Of the United States Government, we might expect better things."

The affair may have this appearance on the Clyde, but we doubt if the Department that apparently endorses the position of Lieutenant Commander F. M. Barber who, while in the service of the United States acts as a "drummer" for Schneider & Co., will either see that the proposition involves a "betrayal of trust" or feel humiliated by any remarks made on the subject.

The Membership of the American Society of Civil Engineers.

The newly published list of members of the American Society of Civil Engineers makes the following exhibit of living members in each class as named:—

Honorary Members	[Hon. M. Am. Soc. C. E.]	8
Corresponding Members		3
Members	[M. Am. Soc. C. E.]	745
Associates	[Assoc. Am. Soc. C. E.]	41
Juniors	[Jun. Am. Soc. C. E.]	106
Fellows	[F. Am. Soc. C. E.]	65
Total Membership		968

The abbreviations within the brackets are those officially authorized by the Board of Direction for the use of members having occasion to designate themselves as such. In addition to the above given membership there are fifty gentlemen whose names are published as subscribers to the Building Fund, who are not members of the Society in any of the classes named. The total list of subscribers to the fund numbers 111, the majority being members of this Society.

A new and very interesting departure in the present list is the division of the membership by geographical distribution. Taking the United States in alphabetical order and giving the total number of all classes represented therein at this date, we have the following exhibit:

UNITED STATES,	NO.
Alabama	4
Arizona	2
Arkansas	2
California	20
Colorado	6
Connecticut	26
Dakota	2
Delaware	3
District of Columbia	17
Florida	4
Georgia	3
Idaho	2
Illinois	32
Indiana	11
Indian Territory	1
Iowa	9
Kansas	10
Kentucky	18
Louisiana	8
Maine	5
Maryland	8
Massachusetts	60
Michigan	17
Minnesota	27
Mississippi	2
Missouri	44
Montana	4
Nebraska	11
New Hampshire	2
New Jersey	32
New Mexico	2
New York	251
North Carolina	1
Ohio	52
Oregon	3
Pennsylvania	104
Rhode Island	17
South Carolina	2
Tennessee	9
Texas	12
Vermont	1
Virginia	9
Washington	7
West Virginia	1
Wisconsin	23
Wyoming	1

The above list shows that every State and territory in the Union, excepting Nevada and Utah alone, contain representatives of the American Society of Civil Engineers.

In addition to the home list the Society has members in countries other than the United States as follows:

Argentine Republic	2
Australia	4
British Columbia	1
Burmah	1
Canada	32
Central America	1
Chili	2
Cuba	1
Denmark	1
England	7
France	1
Germany	2
Holland	1
India	1
Mexico	9
Peru	2
Prussia	1
Spain	1
U. S. of Colombia	3
Venezuela	1

A BEAUTIFUL, bright red French Mansard roof topping out a very fair example of pure Grecian architecture, is the result of the effort of the Superintendent of the Philadelphia Mint to obtain more room. The superintendent, however, claims that as Congress would not buy more ground to extend laterally, he was compelled to go up; and hence this unique specimen of Franco-Grecian architecture.

The Civil Service Inquiry in England.

The system that has gradually developed itself in this country, of removals from office without other cause than a political one and of appointments without regard to merit, with the accompanying evils of political assessments and the holding of office by the tenure of personal or political services to some leader, is universally recognized as injurious to the public service, demoralizing to the individuals concerned and, through them, lowering to the general tone of morals.

As is well known, a system of appointments depending on the results of competitive examinations, modeled greatly on English precedents, has been launched on the country just as Englishmen after nearly forty years of experience with civil service reform, are expressing strong doubts of the working of the system in its home and successfully demanding an inquiry by a Royal Commission.

This is remarkable, as a strong vested interest (a more powerful force in England than elsewhere,) has grown up, which is intrenched in rights of pension and permanency in the tenure of office, the influence of all of which is given to its support and defense.

The more objectionable features of the English civil service which we have not copied, are the division into two classes, the members of which are not easily transferable and also the fact that a transference of service in the same class causes a loss of seniority so that an expert accountant may be kept at clerical duty, for instance. The schemes for examination, as given in a late number of the *Nineteenth Century*, are, for the first class:—

English Composition, History, Language and Literature	500 marks each.
Language, Literature and History of Greece and Rome	750 "
Ditto for France, Germany and Italy	375 "
Mathematics	1250 marks.
Natural Sciences	1000 "
Moral Science	500 "
Jurisprudence	375 "
Political Economy	375 "

Hence the value of either Greek or Latin equals three-fifths of that of mathematics or three-fourths of natural science! For the second class the scheme is:—Handwriting, Orthography and Arithmetic, 400 marks each. Copying Mss.., English Composition, Geography, Indexing or Docketing, Digesting Returns, English History and Book-keeping, 200 marks each.

It seems that the plan of two classes is a failure in so far as it was hoped to attract a body of men with superior education, for while in the first class during ten years only 2½ applicants appeared for each position vacant and the lowest appointees had but 50.8 per cent. of the marks attained by the first candidates, the applicants in the second class have averaged for the same time 6½ for each place. And the complaint is made that a youth trained in a good elementary school stands a much better chance of success than one who has received a liberal education, as a failure in handwriting is twice as disastrous as a failure either in indexing, summarising returns or bookkeeping, and the whole scheme of 1870 and 1875 is "pronounced to have been a grave mistake; it is doctrinaire, academical and quite unsuited to the practical requirements of the public offices. It cannot lead to increased efficiency and despite expectations to the contrary, it has already proved a costly experiment." It is in sore need of present reform.

The *Railway News* says "There is an initial blunder in the adoption of absolutely open competition for such appointments. What should be a test of fitness amongst a select body of nominated candidates has become a struggle for office where hundreds seek for every ten vacancies, and where in consequence the test has crept up by automatic means till it actually ceases to be any test at all. There are dozens of 'colleges,' agencies, tutors and crammers, engaged in teaching the art of 'passing.' The whole structure is based on vested interests "and a chief who goes out of his way to select or promote a fit man, runs the risk of an accusation of favoritism, or of self-interest." "The real cure, so far as we can judge the matter from a 'commercial' point of view, is to make power and responsibility go hand in hand." This, it is claimed, is still the practice in English postoffices.

It is a matter for grave doubt if it would not be better to examine the heads of departments both mentally and morally and then allow them the responsibility of appointing their subordinates. A merely mental examination sometimes results in the prize being carried off by an inferior man with a sponge-like facility for absorbing book knowledge and exuding it again under pressure.

Our Civil Service reform is not tainted with the worst of the English abuses, but it is to be regretted that its advocates, forgetting that wherever we have copied English models, from a dude up, we have made a hopeless failure, did not expend more original thought on so grave a problem.

The Cunard Company and the Trans-Atlantic Mails.

It is reported that the English postal authorities have at length determined to take the Trans-Atlantic mails from the Cunard Company. This company has for nearly forty years carried the mails with safety, and much of the time with deliberation, between England and this country.

During all this time they have never lost a passenger, and have been a thoroughly English institution; taking up a contribution for the Liverpool Sailor's Orphan Asylum, on every trip, and never spending one cent in this country that could possibly be saved to spend on the other side. An example of this is shown in Mr. Cramp's testimony before the Senate Committee on Ordnance and War Ships, viz.:

"I told him, Mr. Burns, president of the Cunard Company, that over 95 per cent. of the business of the Cunarders had been derived from Americans, and that it would be a compliment to their chief patrons to build one of their new ships here. We offered to duplicate the Servia for the same price, and guaranteed to beat her time across the ocean."

This proposition startled Mr. Burns, but he built his next ships on the other side, although he understood it as a business offer, and knew his acceptance of it would have effected a heavy reduction in the price of all ships built in England.

Mr. Burns was true to English interests and we think it is unwise on the part of the English postal authorities to take the contract from a company that has done so much towards the success of the British commercial marine. According to the letter of J. Henniker Heaton, member of Parliament, to the Postmaster General of Great Britain, of September 16th last, that country is now paying subsidies of £365,000, or about $5,000 per day, to various steamer lines and the sum saved by taking the mails from the Cunarders is a very small percentage on this, considering their past services.

It is true that they were well paid in the old days of rivalry between themselves and the Collins line, having received a subsidy of about $30,000 per round trip against $19,000 paid to the Collins steamers till 1855, when it was entirely withdrawn from the American line, though the Collins steamers had invariably made the better time. The principle on which these heavy payments were made is stated as follows in Mr. Heaton's letter above referred to.

"The great packet communication between Great Britain and the British North American Colonies was undertaken upon much higher principles than any connected with mere considerations of revenue. It was felt by the government of Lord Melbourne that it was not wise to allow the only rapid mode of communication between the British Possessions in North America and the mother country to be dependent upon means afforded by the United States. Means were accordingly taken to establish a line of communication of our own. He admitted that this was not done except at a very heavy expense."

However high the principles that actuated the two countries in their respective actions, we have paid England freight money to the amount of about $140,000,000 per annum for some time as a consequence; more than a moiety of which would have remained in our houses if we had kept our subsidies even with those of Great Britain.

Some time since the Cunard line was reorganized on the basis of a "limited" company, with a very high valuation on the steamers then in hand. Since then the mortgages on their new steamers are understood to be about equal in value to their entire assets, and it is possible they may meet with financial trouble, but it would be a pity to see a line which has fought so successfully for its country's commercial supremacy wiped out.

Our Army Ordnance.

Gen. S. V. Benet, Chief of Ordnance, in his last annual report declares the appropriations for ordnance for the present year, viz: $255,000, totally inadequate and that the department has been prevented in consequence from undertaking needed work.

The appropriation of $6,000,000 for steel forgings is believed to be hardly sufficient to arouse much competition among steel makers, though it will serve as a healthy stimulus to firms now supplying Government with gun forgings. The department concurs fully with the recommendations of the Board on Fortifications looking to an appropriation of $21,000,000.

The result of the experimental trials of the 12-inch breech-loading cast-iron rifle gun showed that with a pressure of 28,000 pounds per square inch and an 800-pound projectile the muzzle velocity will not average above 1,750 feet. The total energy developed is about the same as would be obtained from a full power 10½-inch steel rifle, the weight of which is 21.5 tons less than that of the 12-inch cast-iron gun. At the 137th round the erosion had progressed so far that the gun was regarded as unsafe, and the trials were suspended pending the completion of another gun, which is to be lined with a steel tube, with a view to prolonging the lifetime of such ordnance. Should Congress appropriate the necessary money at the coming session, it is believed that both of the 12-inch cast-iron guns to be lined and hooped with steel can be completed within the present fiscal year.

Touching the production of steel gun forgings in this country, the report says the status of the steel works which have thus far undertaken such work is to-day about as follows:

There is one establishment able, with present facilities, to produce all the forgings and of the required qualities for a steel gun of 8 inches calibre, and hoops of all sizes, except the very largest and heaviest, and the breech mechanism and smaller forgings for al calibres. There are two establishments now able to produce the tubes and jackets and miscellaneous forgings for guns of small calibre and hoops of a very considerable size. This represents the best that can be

done to-day by the steel works of this country, and in some respects their experience is yet so new, and the extent of their plant and facilities so limited, that a great deal of time is requisite for the production of the forgings. The orders from the department have also been very limited, but with the prospect of a larger demand there is but little doubt that the works with which the department has had dealings will respond with all needed alacrity in providing the necessary facilities for promptly executing its work. It is thought that these manufacturers could begin delivering the heavier forgings, say for a 10-inch rifle, from eighteen months to two years after date of contract, but the production of such forgings would for several years be slow, as the manufacturers wish to feel sure of their ground before assuming the risk of a number of possible rejections. The production of the tube and jacket forgings for 12-inch guns could be accomplished in from two and a half to three years. Then the time for finishing and assembling the parts—that is, the manufacture of the guns—must be added in making any estimate on the procurement of armament.

Gen. Benet then quotes from the report of the House Ordnance Commission the recommendation that the Government adopt the policy of gradually developing the capacity of the steel factories by requiring them to produce forgings for guns of 8 to 10-inch calibre at the present time. He approves the recommendation.

The Metropolitan Railway of Paris.

The project of M. M. Dupuis, Nibart and Varrailton for a metropolitan railway in Paris, referred to in our last issue, contemplates a circular route tapping the principal railway stations, etc., and is to be built under the following general conditions:

The locomotives used are to be smoke consuming, while gas and steam "will be rapidly drawn into the upper atmosphere," by means not indicated. The viaduct will be constructed of iron trusses resting on metal columns, the width between centers of trusses will be 25.24 feet and will be arranged to give a head-room of from 16½ to 23 feet above the street surface. The viaduct will not follow the streets, as a rule, but will cut through the blocks on an independent route, with thick walls to isolate the tracks from the houses; a thin insulating longitudinal will be placed between the rail and the ties to reduce the noise and vibration; in courts the viaduct will be covered with glass and the cars will have a middle passage with end platforms.

In short, this elevated railway, as described in *Le Genie Civil* of November 6, is very much like the New York system, excepting that the line pierces the blocks instead of attempting to follow the curving highways of Paris.

The Black Auto-Copyist.

Our attention has lately been called to a new process for the duplication of letters, drawings, bills of quantities, etc., that we think would be especially useful in an engineer's office, and as being superior to the well-known blue-process for most purposes.

This is the black auto-copying process. The outfit is simple and in its character is a very near approach to lithography. An especially prepared paper, which is furnished in rolls with the machine, is moistened with water and tightly stretched over a wooden board, forming the receiving surface; the drawing, letter, bill or thing to be copied is then made or written with drawing pen or ordinary pen upon common glazed paper, but with a special ink. As soon as the original is perfectly dry, it is laid face down upon the prepared surface and rubbed by hand to transfer the original. Ordinary lithographic ink is next applied by a roller, exactly as in the lithographic process and the printing is done by pressure with the hand only, no press being required. Several hundred fac-similes of the original can thus be taken from one transfer; but by a re-transfer, two or more copies of the thing wanted can be printed at a single operation.

The resulting impression is in clear black lithographer's ink on writing paper, card or tracing-cloth, anything in fact that has a smooth surface; the lines are sharp and permanent. The auto-copyist is made in nine sizes, ranging from 9x6 inches to 44x32 inches. The New York office is at No. 3 Thomas street, corner of Broadway. The prices range from $11 to $37 for the apparatus complete.

Cast-Iron Pipe.

At the Denver meeting of the American Water-Works Association Mr. G. W. Pearsons, of Kansas City, presented the following notes in connection with a proposed discussion of "Standard specifications for cast-iron pipe":—

Uneven Castings.—In past discussions the fact of pipe being sometimes thinner on one side than on the other has been passed over as a rare, and probably not very serious fault. My experience in laying some 130 miles of cast-iron pipe and its test by direct pressure, leads me to consider it one of the most common and serious faults we have to contend with—a large majority of the broken pipes I have seen showing it. I speak of pipe broken in the ground by pressures.

Quite frequently I have found such pipe broken with an irregular, angular fracture always on the thin side. The fracture instead of being radial, being diagonal to the surface and resembling a rough tear. I have never seen such a fracture made by breaking a pipe in any other manner, and think it must be due to unequal contraction in cooling, caused by the unequal thickness.

Such a pipe is dangerous whether it has passed the test or not—all such pipe which I have seen broken have been tested to 300 pounds, according to the statement of the manufacturers and—notwithstanding they showed no fault on careful inspection before laying, have generally given way before the pressure reached 100 in the ground.

Pipe can be tested for unequal thickness by being rolled slowly over level skids by a single person—any pipe which shows a disposition to get away should be be allowed to—and assisted to do it. The best place to do this is in the pipe factory before the pipe has gone into the tar bath, and I think if the importance of this was realized by the makers, it would be done.

I know as regards water test that all I have seen, has been apparently done with proper care; but do we, or even the manufacturers, know that their workmen are always faithful in this if they are not well watched?

Pipe Weight.—My experience fully justifies the use of as light pipe as indicated by the discussion.

Lead Room.—How can a reasonable uniformity of lead room be maintained? I have had a gang of thirty men up all night, chipping the spigot end of two specials to get them into the bowls they must go into, all standard weight pipe from the same factory, and from the same factory have laid pipe in which the lead room was from ⅝ of an inch to over 1 inch.

Remedy—Call for standard outside sizes of pipes, and require all manufacturers to conform to these sizes, leaving the inner diameter to be governed by the thickness of the pipe. Most of you lay pipes from different factories, and I presume like myself, have suffered from the difference of sizes.

Yarn and Lead.—The yarn should fill to the lead score; the bead on the pipe takes with some irregularity in alignment perhaps 1 inch, yarn 1 inch, lead 1⅝ inches, 3⅛ inches say 3 inches in small pipe, and 4 in large is deep enough for the bowl.

How to get Good Pipe.—Buy it by the lineal foot instead of by the ton; specify, if you desire the minimum thickness to be used, and the water test required; then the manufacturers will take pains to keep out over weight, and will be enabled to make skill in manufacture a paying item in their works, as it is now the superiority of one maker over another in this particular, has no market value; buy specials by the piece.

The last clause in Mr. Pearsons recommendation was novel to the members present and caused considerable discussion; the majority however seemed to regard it as a step in advance, from the user's standpoint.

Loss by Condensation of Steam in Engine Cylinders.

A great source of waste in steam engines, which could be prevented if an efficient non-conducting lining for cylinders could be successfully applied in practice, is the amount of loss due to cylinder condensation. The reason of this loss is sufficiently well understood, and its modus operandi has already been explained in our columns (see ENGINEERING NEWS, October 23, 1886), so that we need not repeat it here. Suffice it to say that by far the greater portion of the loss at present due to cylinder condensation—in fact the whole loss, except the comparatively small amount which necessarily accompanies the work of expansion of steam—would be avoided, if an efficient non-conducting lining for cylinder, piston and rod could be secured.

The extent of loss due to condensation of steam in cylinder, and subsequent re-evaporation at exhaust, will be appreciated by reference to the figures in the following table, presented by Mr. George H. Barrus, as the percentages of loss that occur from cylinder condensation, in the approved type of factory engine, commonly used in this country, viz. unjacketed engines, having cylinders exceeding 20 inches in diameter, and supplied with dry steam.

Percentage of Stroke Completed at Cut-off.	Cylinder Condensation at Cut-off. Percentage of whole Consumption of Feed Water.
5	42
10	34
15	29
20	26
30	22
40	18
50	14

In relation to this table we may say that the percentages of loss for 20, 15, 10 and 5 per cent. cut-off are if anything rather low, and that with engines, whose cylinders are of smaller diameter, all the percentages will, even when representative of good practice, turn out somewhat higher.

The importance of preventing this loss, and the money value such saving would represent, must be patent to all. It is, therefore, of special interest to chronicle any intelligent and well designed attempt in the direction of introducing a non-conducting lining in cylinders, whether successful or not, and the pertinency of the account of Mr. Charles E. Emery's experiments, detailed by him in the last Transactions of the American Society of Mechanical Engineers, just at hand, will not be questioned.

Although Mr. Emery's experiments in relation to non-conducting linings for engine cylinders date back as far as 1866, it is only now that an authentic account of them is given to the engineering public. We deem the question of such interest that we will reproduce Mr. Emery's remarks in their entirety, in another issue.

We know that other prominent steam engineers are earnestly at work at the present time, in an attempt to secure an efficient, effective and durable non-conducting lining for engine cylinders and pistons, and can only wish them success in perfecting a compound suitable for engine use; for certainly such a lining offers, as an economical basis, a chance of success, in decreasing to a minimum the loss by condensation, which compounding, or any other expedient of steam use, can not approach.

PERSONAL.

ASSISTANT U. S. ENGINEER WARE, with a corps of engineers, is making a new coast survey near Chatham, Mass.

J. BROADDUS, of Wichita, Kan., is Chief Engineer of the Wichita & Trinidad R. R., the surveys for which are now in progress.

J. L. COWAN is engineer-in-charge of the surveys of the Columbus & Florida R. R., with headquarters at Columbus, Ga.

D. W. C. PERRY is Chief Engineer of the Parsons & Pacific R. R., with headquarters at Parsons, Kan.

A. M. KINSMAN is the engineer in charge of the work on the Chicago, Madison & Northern R. R.; the grading for which has been commenced at Madison, Wis.

EDWARD A. GARVEY has been appointed Chief Engineer for Louisiana, for the Texas & Pacific R. R.; GEORGE NOBLE has been appointed General Manager.

J. A. LATCHA has been appointed Chief Engineer and Superintendent of Construction for the contractors for the Duluth, South Shore & Atlantic R. R.; his headquarters are at Marquette, Mich.

ALFRED L. ELTONHEAD has been appointed Chief Engineer of the American Contracting & Dredging Co., Philadelphia, Pa.: the company has about ten large dredging machines at work on the Panama canal.

W. W. CARTER, Superintendent of Bridges with the Hannibal & St. Joseph R. R. Co., has resigned to accept a similar position with the St. Joseph & Grand Island R. R. Co.

EDWARD GALLUP, General Superintendent of the Boston & Albany R. R., has resigned to accept the position of General Manager of the Lake Shore & Michigan Southern R. R.

MR. HEDGES, an engineer on the Sanford & Lake Eustis R. R., Florida, has resigned to accept a position on the new road between Plant City and Palma Sola, Fla.

H. SMITH has been appointed Superintendent of Bridges, Buildings and Water Stations for the Toledo, Ann Arbor & North Michigan R. R., with headquarters at Azalia, Ind.; GEORGE L. DAVIS has been appointed Roadmaster, with headquarters at Toledo, O.

MR. DANA C. BARBER has opened an office in Philadelphia and offers his services to the citizens of that place in the securing of better sanitary conditions in their homes. Mr. Barber has had exceptional opportunities in investigating the best methods of plumbing and house drainages, is a graduate civil engineer, and is endorsed by well-known engineers for his knowledge in matters pertaining to sanitary improvements and for his conscientious, careful and intelligent reports. We are personally acquainted with Mr. Barber and wish him every success in his new venture.

JAMES TATE, aged 60 years, appeared before the Mayor of Pittsburg, Pa., on November 10, and asked for lodging at the city's expense, being without money, home, or friends. MR. TATE claimed to be a civil engineer, born in Bristol, England, and at one time employed on the Great Western Railway, and for thirteen years as an engineer in India. He says he was for some years, Resident Engineer at Poona, on the Great Indian Peninsula R. R., and also claims to have been the author of a number of papers on engineering subjects. He drifted to Australia and from thence six years ago to this country.

LATE MOVEMENTS OF THE ENGINEER CORPS, U. S. A.—MAJOR AMOS STICKNEY is ordered to Mount Carmel and Graysville, Ill., and Kelly's Ripple, White River, Ind. LIEUT. COL. GEORGE L. GILLESPIE will proceed to Newburyport and Gloucester Harbor, Mass. CAPT. DANIEL W. LOCKWOOD is ordered to duty at St. Joseph, Mich. LIEUT. WM. M. BLACK will proceed to Indian River, Tampa and Clear Water harbor, etc., Fla. CAPT. WM. H. BIXBY is ordered to Alma, and other points in N. C., and Cheraw, S. C., making sundry examinations of rivers and harbors. CAPT. WM. T. ROSSELL will proceed to Wilson's Point, La. LIEUT. COL. HENRY M. ROBERT will inspect the forts opposite Fort Delaware and at Finn's Point, N. J. CAPT. DAN. C. KINGMAN is relieved from duty as engineer officer, Dept. of the Platte, and will be stationed at New Orleans, relieving MAJ. CHARLES W. RAYMOND, who will report to the Chief of Engineers at Washington, D. C. The board on building and repairs of levees on the Mississippi river, consisting of MAJ. CHARLES W. RAYMOND, CAPT. WM. T. ROSSELL and CAPT. WM. T. LEACH, is ordered to convene at an early date at Memphis, Tenn., for the purpose of taking action on closing the gaps in the Yazoo and Tensas front levees.

HERBERT MALLORY HOXIE, late First Vice President and General Manager of the Southwestern system of railroads, died at his residence in New York on November 23d. Mr. Hoxie was born at Palmyra, Wayne Co. New York, on December 18, 1830, but early in life removed to Des Moines, Iowa. In 1850 he traveled overland to California; but failing in his attempt to make a fortune in the gold fields, he returned to his farm in Iowa. He later married a niece of the Hon. Thomas Mitchell, and became actively engaged in politics, being chairman of the Republican State Committee and, about 1861, the United States Marshall of Iowa. He was General Superintendent of the Union Pacific Railway during its construction, and won fame by his connection with that road, and his personal active service. In 1870, he was appointed General Superintendent of the International R. R. of Texas, John S. Barnes, President, and was General Manager of the International and Great Northern R. R. when these two roads were consolidated in 1872. In 1880 he was General Manager of the Texas Pacific under Colonel Thos. A. Scott, and in 1881 held the same position on the Iron Mountain, St. Louis & Southern, and all the roads controlled by Mr. Gould in Texas. In 1883, when the Wabash Road was annexed, Mr. Hoxie was First Vice President of that road and the Gould Southwestern system, and in 1885 he was made General Manager of the system in addition. He leaves a fortune of between 100 000 and $200,000 with no children.

MR. E. A. D. PARKER, Civil Engineer and Surveyor, Nelson, Neb., a long time friend and supporter of ENGINEERING NEWS (and thence naturally a first-class member of his profession), has laid by the transit and chain for the present and will try his hand at editoral work upon *The Time Table*, a prosperous looking weekly journal published at Nelson, one-half interest in which has been purchased by MR. PARKER. We hope he may be very successful in his new venture.

Liverpool Engineering Society.

The usual fortnightly meeting of this society was held at the Royal Institution, Colquitt-street, Liverpool, on Wednesday, November 3rd; Mr. Coard S. Pain, Assoc. Inst. C. E., president in the chair. A paper by Mr. Ludwig Benjamin, M. Inst. N. A., entitled "The Practical Use of Stability Calculations," was read by the author. After a brief review of the development of stability calculations, the author, who has taken an active part in the investigations of that branch of science, dealt with the question why these calculations are not made use of in a large degree by shipowners.

He pointed out that this was mainly due to three sources, and that it rested with three classes of men to improve upon the present state of things. Firstly, the naval architect who, instead of giving the results of his calculations in a manner easily understood by those who are supposed to make use of them, adopts a system of curves and diagrams which captains and others cannot be expected to understand. The author proposes a tabulated form which could be understood without scientific knowledge, and which meets all the requirements. Secondly, the shipowner, who in the case of mixed cargoes, often adopts a system of stowage which renders it impossible for and guiding information to be given by the naval architect, and which results in vessels being sometimes sent to sea in an absolutely unstable condition.

The author pointed out that it should be a matter of legislation to amend this dangerous state of things, which is of far greater importance than the question of freeboard, upon which the Board of Trade has for so long a time been occupied. Thirdly, the sailor, to whom a certain amount of blame must be attached for having so little confidence in the results of scientific investigation trusting as he does almost entirely to his own experience which experience, the author pointed out, in many cases prove misleading and have dangerous results.

CORRESPONDENCE.

Quick Triangulation.

ENGINEER'S OFFICE L. H. & N. C. R. R.
LYNCHBURG, VA., November 1, 1886.

EDITOR ENGINEERING NEWS:

Under the most favorable circumstances, measurement across streams by the usual methods in surveying and locating railroad lines is attended with delay, but when obstacles to establishing a base, or planting an instrument, present themselves much valuable time in the field is lost, both in clearing the way and calulating the quantities.

While conducting some surveys a few years ago through a country where streams with low marshy and densely wooded banks were numerous this loss became so serious that your correspondent devised the following simple application of the principle of stadia measurement which, so far as he knows, is new and may interest some of your readers.

It proved entirely satisfactory in practice, saving the party a vast deal of time and giving sufficiently accurate results for all practical purposes. Before adoption numerous trials were made in the open field and with an ordinary transit reading to minutes, the results obtained at four or five hundred feet, seldom differed more than one or two-tenths of a foot from the distances measured by a chain between the points. Let

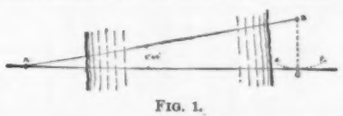


FIG. 1.

A be the position of the instrument where the line of survey strikes the stream, B, the point on the opposite bank whose distance from A is required. Place a stake at B and drive a tack half way in the top of it. Sighting on the tack deflect 5° 44′ to the line $A\,C$. Let the flagman hook the ring of his tape over the tack and walk backwards towards C, holding his thumb nail or a bit of paper on the tape and swinging it slowly in the arc $d\ f$ until you place his thumb nail, at the greatest elongation of the arc, exactly on the line $A\,C$. This makes $A\,C\,B$ a right angle.

The distance $B\,C$ thus obtained multiplied by ten, with one tenth of a foot added for every one hundred feet of the product will give the required distance $A\,B$ or

$$A\,B = B\,C \times 10 + \frac{B\,C \times 10}{100}$$

For in the triangle $A\,C\,B$ the angle at C being 90°, that at A 5° 44′, and the side $B\,C$ being known, we have

$$A\,B = \frac{B\,C}{\text{Sine } A}$$

The method may be used for long distances by measuring the right angle roughly with a square, or by the eye, for $B\,C$ would then become too long to swing conveniently in an arc. WM. W. BLACKFORD.

[We give the above method of "quick triangulation" because it may be new to some, but the principle and application are really very old. The usual method, with the transit at A is to deflect one degree, and measure the side $B\,C$. Then, as a deflection of one degree is equivalent to a sine of 1.75 feet in a distance $A\,C$ = 100 feet, the real length of $A\,C$ is found very easily. If $B\,C$ = 8 feet, the equation would stand: 1.75 : 8 :: 100 : 457 14. A better method of fixing the right angle than by swinging the tape, is to set a flag or a peg on the line $A\,C$, 6 feet from C, then with the tape at C describe a radius of 8 feet, and from the new peg a radius of 10 feet and the intersection of these radii will mark a point at right angles to $A\,C$, which right-angle line can be prolonged any distance required.

In our same old note-book which contains the above, we find a method for triangulating with a level and rod, which may be useful to some of our readers; it is shown in Fig. 2. This is like the other, founded upon similar

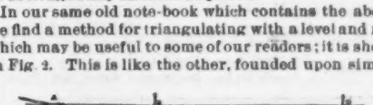


FIG. 2.

triangles. Set the rod on the near bank and measure the distance $A\,B$; with two leveling screws on the line of sight lower the object end of the telescope until it strikes an object at E on the far bank; measure the distance $B\,C$ on the rod, and then $D\,E$ by levelling up the instrument again. You then have $B\,C : D\,E :: A\,B : A\,D$. All of these methods are more or less approximate, but are often convenient in hasty work.—ED. ENG. NEWS.]

Report of the Chemist of the Engineer Department of Washington, D. C.

We are indebted to Mr. E. J. De Smedt, Chemist District of Columbia and General Inspector of Cements and Asphalt Pavements, for the courtesy of an advance copy of his report to Col. Wm. Ludlow, Engineer Commissioner of Washington, D. C., bearing date November 17, 1886. We publish in full the portion deemed most interesting to our readers, or the part relating to the Engineer Department.

"For the Engineer Department nineteen analyses of pump water have been made, the results of which have been reported to Lieutenant Townsend.

The Potomac water supplied to the district have been analysed once a month with the following results:

ANALYSES.

One liter, 1,000 grammes, of this water contains milligrammes-parts per million.

Number.	Appearance.	Solid residue.	Organic volatile.	Mineral matter.	Free ammonia.	Albuminoid ammonia.	Nitrites.	Nitrates	Chlorine	Microscopic examination and gelatine test.
1	milky	92.0	48.0	44.0	0.12	0.05	Traces	2.0	4.5	good.
2	clear	90.0	30.0	60.0	0.09	0.06	"	1.7	4.0	"
3	muddy	94.0	32.0	62.0	0.1	0.08	"	2.5	4.6	"
4	clear	90.0	30.0	60.0	0.1	0.055	"	2.0	4.5	"
5	clear	91.0	39.0	61.0	0.08	0.06	"	2.1	4.7	"
6	muddy	96.02	45.0	51.02	0.12	0.10	"	2.75	4.2	"
7	milky	91.07	32.0	59.07	0.09	0.07	"	2.00	4.0	"
8	clear	90.00	30.00	60.00	0.1	0.05	"	2.00	4.02	"
9	clear	90.02	31.00	59.02	0.08	0.06	"	2.05	4.04	"
10	milky	92.00	30.00	62.00	0.1	0.09	"	2.0	4.60	"
11	milky	90.50	30.07	59.43	0.09	0.07	"	2.1	4.50	"
12	clear	90.00	30.00	60.00	0.06	0.05	"	2.0	4.00	"

The above table of analyses shows that the water supplied to the district, varies somewhat in quality occasioned by climatic causes, but that nevertheless, the Potomac water is always a healthy beverage.

I have also, as in previous years, made daily analyses, as the work progressed, of the nature of asphalt pavements laid in the district. The average percentage of asphalt cement in 192 samples is chemically pure asphalt cement..... 9.40 commercial 14.10
Carbonate of lime..... 9.00
Sand and stone dust..... 81.60
100.00

The average composition of asphalt blocks is chemically pure asphalt cement.... 7.60 commercial 11.40
Broken stone (Co^2 Co^3)..... 92.40
100.00

These compositions give satisfactory results. Weekly reports of the analyses were submitted to Captain Mahan, Assistant to Engineer Commissioner, D. C.

TABLE 1.—LIGHT-BURNED HYDRAULIC CEMENTS.

Name.	Fineness No. 50 sieve.	Quantity of cement and sand.	1 day	5 days	10 days	20 days	30 days	2 mths.	6 mths.	12 mths.	Remarks.
Shepherdstown..	0	Neat cement	32	80	105	169	200	280	363	414	
		2 sand									
		1 cement		26	30	180	100	125	160	203	
Roundtop	5	Neat cement	45	98	159	169	183	240	300	384	
		2 sand									
		1 cement		20	31	72	98	126	152	178	
Cumberland..	7	Neat cement	57	98	150	170	218	240	350	389	
		2 sand									
		1 cement		23	31	75	102	115	155	170	
Norton Rosendale	6	Neat cement	40	42	45	65	90	150	295		
		2 sand									
		1 cement			15	25	46	95	172		
Akron	0	Neat cement	50	85	155	215	350	380	478		
		2 sand									
		1 cement			35	80	135	190	265		
Improved Union	0	Neat cement	95	150	190	250	375	420			This cement was not used here, but was sent as sample

TABLE 2.—PORTLAND HYDRAULIC CEMENTS.

Name.	Fineness, Sieve 50.	Quantity of cement and sand.	1 day	5 days	10 days	20 days	30 days	2 mths.	6 mths.	12 mths.	Remarks.
Brooks & Shoebridge	6	Neat	100	305	350	380	420	560	620	737	Imported Cement.
		2 sand									
		1 cement			150	200	240	250	300	385	"
Dyckerhoff	5	Neat	95	250	325	330	350	482	580	682	"
		2 sand									
		1 cement			165	172	240	276	302	360	"
Star	3	Neat	200	450	500	520	559	608	700	789	"
		2 sand									
		1 cement		200	225	280	370	388	400	440	"
Giant		Neat	130	300	380	400	466	563	600	746	American Cement.
		2 sand			161	222	250	279	307	389	"
		1 cement									

All the hydraulic cements used on the public works of the district have been submitted at my laboratory to a daily test as to their tensile strength, and weekly reports of the results obtained, together with the places where used were submitted to Captain Mahan and Lieutenant Townsend. I have also made analyses of the different cements is use in order to find out the causes of the superiority or inferiority of the hydraulic cements employed.

The following tables show the average tensile strength per square inch of the various kinds of light-burned (home made) and Portland Cements in use here.

Light-burned (home made) hydraulic cements.

The cements of this class used in the district are, the Shepherdstown Potomac cement, the Roundtop Potomac cement, the Cumberland Potomac cement, the Norton Rosendale cement and the Akron cement, this last cement has come into use here rather recently.

Chemical Analysis.—Chemical analysis is the only way to predict the quality of hydraulic cement and to adjust the component parts of its composition, whenever necessary. Here we have an example of this statement in the Shepherdstown cement. On reference to my previous annual report it will be found that this cement contained 68.61 per cent. bibasic silicates, and that its tensile strength was in one year 360 pounds. During this fiscal year I have found by analyses that this same cement contains 72.60 per cent. of bibasic silicates and that the average tensile strength of one year is 414 pounds. Thus there is an increase of 3.99 per cent. of bibasic silicates, and in one year an increase of tensile strength of 54 pounds.

Hydraulic cements heretofore were sold on a reputation obtained through certificates given by persons having used many thousands of barrels, but some had never tried to discover by actual tests their comparative qualities. Hydraulic cements, principally the light burned, were formerly judged by their dark or light color, for the darker the cement the better it was in the general estimation. Some of this ignorant prejudice still exists, but the intelligent consumer tests what he contracts for by the testing machine, and by that means finds out that the black or brown coloring matter has no virtue whatever, being so much inert matter naturally existing or fraudulently introduced to satisfy this public ignorant prejudice.

Another prejudice in regard to Portland cement, is that to be good it must be imported. Portland cement can be made, and is made, in this country, of as good quality as manufactured elsewhere. The use of the testing machine will corroborate the correctness of my statement. In this office the hydraulic cements are judged, accepted or rejected on their intrinsic merit.

Sand Test.—Hydraulic cement though tested neat, is hardly, if ever, used in that condition, but is mixed with sand to make mortar for the construction of walls, etc., or mixed with broken stone, etc., to make concrete. As a matter of fact, a hydraulic cement which shows great tensile strength will generally have great power of adhesion if fairly employed.

The desirability of ascertaining the adhesive power of a cement has led to what is known as the sand test. It is done by gauging cement with sand in certain fixed proportions and testing the briquettes, made in the ordinary manner, for tensile strength. But it is essential, in order to obtain satisfactory results, that the sand should have the required physical and chemical qualities.

I have seen sands, though clear and sifted through the same sieves and not unlike under the microscope, give results that differed greatly when used with the same cements. This led me to investigate the causes of the different results apparently obtained under similar conditions.

In Germany, the government sells a standard sand, to all who require it, at a moderate price. Here the contractors must obtain their sand where and how they can to be accepted by the government under certain specifications.

Two very essential points in selecting sand for making mortar should be observed. First: That the sand be of a free silicious nature, without the admixture of carbonaceous sand or clay. Silica and silicates have great affinity for hydraulic cements and produce great adhesive power, while carbonates, such as carbonates of lime, etc., have much less and give poor results. In a clean washed sand containing 20 per cent. of carbonaceous sand used with hydraulic cement, the tensile strength was reduced 30 per cent. After having been treated with hydrochloric acid and washed in order to eliminate the carbonates from the sand, its inactive adhesive power was restored. Thus in selecting sand a sample ought to be treated with hydrochloric acid, and if any effervescence is perceptible, it is an indication that it contains carbonates, and the sand should therefore be rejected.

Second: The voids of the sand must be ascertained by first drying the sand, and then filling a given measure with it well packed, and filling the voids with water, the quantity of water used being equal to the voids in the sand. The quantity of the hydraulic cement employed with sand to make mortar, which will give excellent results, should be equal to the volume of voids + 2 per cent.

The sand generally employed in the District of Columbia, has voids from 31 to 32 per cent. The specifications for mortar are two parts of sand with one part of cement = thirty-three and a third per cent. of hydraulic cement. By these proportions the voids are well filled, and the results obtained are very satisfactory.

I would therefore recommend that it is important that the percentage of cement used in mortar with sand should be at least equal to the percentage of voids in sand.

A sand having 40 per cent. of voids was mixed with 33 and a third per cent. of hydraulic cement, and the average tensile strength of this (10 briquettes) was 15.50 pounds per square inch after ten days, while the hydraulic cement of the same barrel mixed in the same proportions—two of sand to one of cement, the sand having only 32 per cent. of voids—gave in ten days an average tensile strength per square inch (10 briquettes) of 62 pounds.

The importance of a sand test cannot be denied and is, as we have seen, indispensable. A great deal has been written on this subject without giving much information, but in reality it is a simple matter. To test the cement with a standard sand is out of the question. The sand to be tested is the sand to be used which, combined with the tests of the hydraulic cements to be employed will give the necessary information as to the ultimate strength of the structure.

To Weld Steel to Iron or Steel

Mr. Paul Herzog, of Peterswaldau, gives the following as a special composition discovered by him for use in welding steel to steel or to iron:—

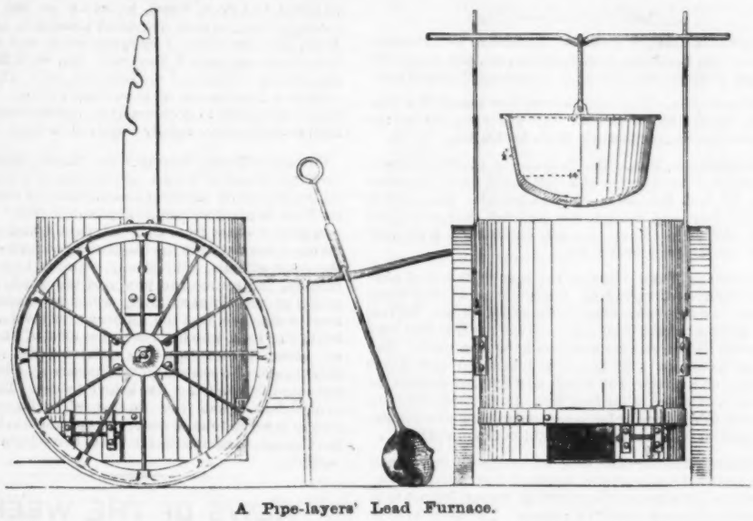
500	grammes	Borax
70	"	Sal ammoniac
70	"	Poursiate of Potash
35	"	Unrusted Iron Filings

This compound is to be pulverized in a mortar, and then turned into a sheet-iron pot or crucible; water is added until a thick paste results and then the crucible is put over a wood-fire and the contents constantly stirred. The resulting mass resembles pumice stone with green and gray streaks; this is cooled, pulverized and is at once ready for use.

Le Genie Civil, November 6.

Lead Furnace for Pipe Layers.

Objection having been made that the lead furnace pictured in connection with "Municipal Engineering," in Providence, R. I., was "old-fashioned," we illustrate herewith a later type, as used by Mr. A. H. Howland, of Boston, Mass., in water-works construction.



A Pipe-layers' Lead Furnace.

In this appliance the furnace is 24 inches in diameter by 28 inches high; the wheels are 30 inches in diameter. The ladle shown is of the usual pattern and style, but it has a piece of common gas pipe sliding loosely on the handle, which serves as a cool holder in handling the ladle, carrying it or in pouring.

The lead kettle differs from ordinary types in having an unusually thick bottom (three-quarters of an inch), which lessens the danger of burning the lead. This furnace and the form of kettle and ladle shown have been thoroughly tested in the practice of Mr. Howland and found most satisfactory in all respects.

LITERATURE.

Journal of the Association of Engineering Societies, Oct 1886. with title and index to Vol. V which is closed by the present number.

CONTENTS: "The Application of Electricity to Railroad Signaling," by GEORGE W. BLODGETT. "Notes on the Application of Railway Signals," by G. R. HARDY. "Wood Pulp and Some of its Peculiarities," by MARK L. DEERING; with discussion, "Importance of Economical Generation of Steam Power to the Development of Manufacture in St. Paul," by F. T. HAMPTON. "Progress in Electric Lighting," by N S. PORSONS; with discussions.

The first of the papers on the above list, briefly describes the electric apparatus for signaling as used on the Boston & Albany R. R.; it treats of line block signals with rail circuits and of the inter-locking systems. The second paper is in the same line, but describes especially the overlapping block system. The paper of Mr. Deering is a frank statement of experiments, failures and ultimate success in the attempt to make oil and water-tight seamless barrels from wood pulp. While a perfect barrel, weighing 30 to 35 pounds, and thoroughly proof against the soaking of oil or water, can be made the enterprise is not a commercial success because they can not be made of uniform strength; some of them will fail under the rough handling in transportation. In the course of the discussion some interesting points were brought out relating to wood pulp and its manufacture. The paper-stock made from this material was worth from three to eight cents per pound; the last is used in making the finest kinds of writing paper. 85 to 90 per cent. being pulp. Gunpowder is made from wood-pulp at Black River, N. Y. but it is worth from $4 to $5 per pound. In referring to the manufacture of barrels from pulp, they were described, as being ⅜ inch thick and heavier than a wooden barrel, the material used in a barrel being worth 20 cents; the sizing used was milk and lime mixed with pulp; it is perfectly oil-proof when dried at a temperature of 250° F. The paper of Mr. Hampton is called out by the expressed fact that St. Paul must in the near future become a manufacturing instead of a distributing point merely, as the great railway enterprise of which it was once the financial and business center are now completed, and the lack of this stimulus to progress is being felt. The paper discusses the forms of power best adapted to that region, and the distribution of power from steam or gas, and concludes by recommending steam after the system of the New York Steam Heating Co. The final paper is a brief but satisfactory sketch of the progress made in electric lighting, and outlines the principle which govern the conversion of mechanical into electrical energy, treats of the construction of dynamo-electric machines and the general system of electric lighting.

Electricity in the Service of Man: a popular and practical treatise on the Applications of Electricity in Modern Life. From the German of Dr. Algred Ritter Von Urbanitzky. Edited, with copious additions, by R. WORMELL, D. Sc., M. A., with an introduction by JOHN PERRY, M. E., F. R. S., Professor of Mechanical Engineering and Applied Mathematics at the City and Guilds of London Technical College, Finsbury, with nearly 850 illustrations, 1886, Cassell & Co., Publishers, Size, 6x9 in.; pp. 859; Price $6.00.

While the public generally are indebted to the authors of this timely volume, to even outline its contents would make a pamphlet in itself. It is sufficient to say that the treatise commences with a sketch of the early and classical references to magnetism, gives the various steps of the development of magnetism and electricity through the Middle Ages and thence on to the discoveries of Faraday and the wonderful advances made in this branch of science in less than the last two decades. As late as 1870 the science of electricity was without text-books; experiments had been published in ponderous papers for nearly a century before, but these were buried away in the transactions of learned societies, undigested and practically inaccessible to the general student. But in 1870, Dr. Everett, Fleeming Jenkin and Clerk Maxwell made clear the full meaning of Ohm's law, explained electro-motive force, difference of potential, resistance, current, capacity, etc., and established the fact that they could be calculated with as much certainty as a problem in dynamics. The teaching of electricity as a science dates from about this period and this powerful element in nature ceased to be the subject of mere lecture-room tricks and exhibitions of startling effect.

The present treatise, as its title indicates, is a popular and practical rather than a profoundly scientific treatment of the subject of electricity; and Dr. Urbanitzky makes considerable use throughout of the analogy between the flow of water and a flow of electricity, but simply as an illustration and to render easier the comprehension of the meaning of terms and the relation between the different electrical quantities. In the division into subjects, Part I is devoted to the discussion of magnetism, statical electricity, the galvanic current and animal electricity; Part II treats of the multitude of machines for producing electricity, and galvanic batteries, with handsomely engraved illustrations of the various types; the second division of Part II discusses and explains the electric light, from its earliest forms to the latest development, electro-chemistry and metallurgy, electricity as a motive power, and the telephone, photophone, pherope and phonograph, and concludes with a detailed history of the electric telegraph.

Excellent as this production is generally with its vast amount of information, one important omission must be noted, and that is a table of definitions of terms used in connection with electric science. To the expert, the expressions *volt, ampere, ohm, farad, coulomb E.M.F.* etc., may be household words; but it is not so with the general public, and this work professes to be a "popular treatise." The meaning of these terms can generally be dug out of the text, but it would have simplified matters to have arranged them somewhere in tabular form.

Scribners Magazine.—Charles Scribner's Sons, of New York, will commence on January 1st, the publication of a new magazine. It is to be fully illustrated in a manner representing the most spirited, sincere and original work in the artistic field. The initial number will contain a series of unpublished letters of Thackeray with fac-similes of Thackeray's own drawings; Reminiscenses of the Seige and Commune of Paris by ex-Minister Washburne; Glimpses of the Diaries of Gouverneur Morris; early New York and New England Society; Novel, by Harold Frederic, etc. An early article on Coast Defence, by Cap. F. V. Greene, U. S. Eng's, is also promised. The price of this magazine will be $3.00 per annum.

Cassell's Family Magazine for December.

Readers of *Cassell's Family Magazine* will regret to find that the serial story, "A Wilful Young Woman," is concluded in the December number. "Harlowe's Helpmate," a shorter serial, is also concluded. A paper on the "Library of the British Museum" written by Dr. R. Garnett, the assistant keeper of printed books, is as interesting and as accurate as might be expected from such a source. This is followed by a poem, "A Girl's Story," which has the honor of a frontispiece illustration. "The Family Doctor," this month, discourses on rheumatism, its causes and cures. As usual what he says is as sensible as it is simple to act upon. In the series of papers on "Stirring Scenes in Stirring Lives," the adventurous career of David Livingston is set forth for our admiration. "A Tour through Little France" describes an old part of London, around Soho Square, once so fashionable, but now given over to foreigners and pawn brokers. "The Giant's Bones" takes us from London to Persia and introduces us to one of the fascinating stories of that far-away land. "Mirror and Crystaline Painting" tells how one may decorate one's windows and looking-glasses, and make them blossom as the rose. A. G. Payne gives his second and last paper on "Cooking at Sea." "Amongst the Lead Mines," introduces us to a class of workers quite new to us. There are short stories and pictures, and the two fashion letters from London and Paris, which the lady readers of this magazine have learned to depend upon.—*Cassell & Co., 15 cents a copy, $1.50 a year in advance*

Transactions and Proceedings of the American Society of Civil Engineers. August and September, 1886.

CONTENTS:—August number, "On the work done for the Preservation of the Dam at Holyoke, Mass., in 1885, and some Studies for a New Stone Dam for the same place," by CLEMENS HERSCHELL. September number, "Evaporation," by DESMOND FITZ GERALD.

The first of the above is an exceedingly valuable and interesting paper read on Feb. 17, 1886. Mr. Herschell commences with the history of the water-power at Holyoke, and describes the first and the second, or present, dam; he then details the flood experiences and breaks in the dam to 1885, and after showing how various more or less futile attempts were made to mend breaks, he enters into the story proper, which is a very satisfactory description of the plan adopted and successfully carried out in 1884-85 for the prevention of any future breaks. Although the author modestly expresses a doubt of the value and interest of this paper to his professional brethren, it has undoubted value from its careful detail of simple but ingenious devices, adopted, and aside from this has interest from the very agreeable manner in which the subject is handled by Mr. Herschell. Every important feature is handsomely illustrated, and in addition a number of photo-types show the work in its various stages. The paper concludes with a study and diagram of a proposed stone dam for the same site.

Mr. Fitz Gerald's paper is also valuable as the recorded results of careful observation, extending over some years, upon the important subject of evaporation. The author first investigates the laws governing this phenomenon, together with the influence of heat, wind, sun, depth, etc.; he then enters into a description of the apparatus used by him in his experiments, (illustrated by cuts and phototypes) and finally proceeds to give some of his results and the deductions from them. These experiments and the discussion thereon are confined almost entirely to the natural evaporation from water surfaces.

The Friction of Hydraulic Rams.

A correspondent of *The Engineer*, of November 5th, gives the following formula for the friction in hydraulic rams, as deducted from a series of experiments made by Mr. Hicks, of Bolton, England.

Let P = Pressure of water under ram in pounds per square inch.
D = Diameter of ram in inches.
F = Total friction of ram leathers in pounds.

Then

(1) $$D \times \frac{P}{32} = F$$

(2) $$F \times \frac{32}{D} = P$$

For example; with a ram 7 inches in diameter and 5 pounds per square inch due to friction of ram, we have—area of ram = 38.48 square inches × 5 pounds per square inch = 192.42 pounds total friction of leathers.

By formula (2)

$192.42 \times \frac{32}{7}$ 879.6 = pressure per sq. in. of water under ram and

pounds per square inch × 39.48 sq. in. = 33,865.9 unds—192.42 = 15 tons nearly, thrust on each ram.

The World's Merchant Navies.

Interesting particulars as to the merchant navies of the world were given lately in an inauguaral address by the President of the Northeast Coast Institution of Engineers and Shipbuilders, Mr. W. T. Doxford, shipbuilder. He gave the numbers of the steamships above 200 tons as 7,889, and the tonnage as 9,855,560 gross. He remarked that the average increase in the size of the vessel has been from about 730 tons 30 years ago to over 1,400 tons at the present time. The existing steamers of the world he classes into three divisions—first, some 3,797 boats of modern type, capable of earning profits for some time to come; second, about 2,573 steamers which might be made efficient by changes of engines or boilers and similar renewals; and third, about 1,519 old and obsolete in type, owing to the condition of the engines, the hull, or the arrangements which did not allow of profitable working against modern steamers. Mr. Doxford estimates that it would take £9,500,000 to put into a state of efficiency the vessels of the second class, the largest portion of that amount needing to be spent in new engines and boilers. Such an expenditure would, however, give a good return in lessened fuel expenditure, owing to the more economical working of the more modern triple expansion engines, and to the larger cargo space which would be afforded, as less coal for the steamer's consumption would be necessary on board.—*Manchester Guardian.*

THE PITCH LAKE IN TRINIDAD.—The hearing of the petitions of Mr. Joseph Previte, Mr. Thomas B. Watson, and others in relation to their interests in the Pitch Lake in the island of Trinidad, has occupied the attention of the Judicial Committee of the Privy Council within the past month. Mr. Elton, Q.C., and Mr. W. B. Kingsford were counsel for the petitioners; Sir Horace Davey, Q.C., Mr. Arthur Cohen, Q.C., and Mr. Jeune for opposing parties. The petitions had reference to the management of the Pitch Lake, which is a mineral area of vast extent, filled with deep and valuable deposits of asphalte. The parties are importers of this Trinidad asphalte to America and other countries, where it is largely employed for paving and roofing purposes. The Government of Trinidad had reserved a portion of the lake, to the alleged detriment of the trade, and the petitions raised various questions as to the way in which, under the regulations laid down by the Government, leases of the property had been granted. At the close of the case for the petitioners, their lordships, without calling on the other side, intimated that they would report to Her Majesty that the petitions should be dismissed with costs.—*The Colonies and India.*

WATER.

(For further items see page V).

ASHLAND, ORE., is probably discussing water-works, as the City Recorder, J. S. Eubanks, Sr., has requested a copy of Statistical Tables of American Water-Works.

ATLANTA, GA.—The City Council has awarded a contract for six filters for the city water supply to the Hyatt Filter Co., of Newark, N. J., for $51,875.

WILMINGTON, DEL.—The Trustees of the Poor are rejoicing over the success of a well bored on their premises by J. E. Robinson, of Philadelphia. The well is 180 feet deep, and though the contract only called for 2,000 gallons per hour, they are obtaining a little over 5,000; the well cost only $1,100.

NASHVILLE, TENN.—During the year 18,935 feet of pipe have been laid, including 13,000 feet of 36-inch force mains; the aggregate length of pipe is 42 miles. Eleven new hydrants have been put in, seven are free and four for stock; 180 service connections have been made. The pumps have run 7,736 hours and pumped 2,836,914,878 gallons, an average of 21 hours and 7,777,369 gallons, 25 per cent. of which is for free use. It is recommended that the new reservoir be completed as soon as possible, the present one holding only eight hours supply.

DENISON, TEXAS.—The new water-works have been accepted by the city after a thorough test of the system. There are 9¼ miles of distributing mains, from 6 to 16 inches in diameter, and 75 hydrants. The standpipe is located on an elevation and is 125 feet high and 15 feet in diameter; it gives a pressure of 75 pounds per square inch at the hydrants; this pressure may be increased by 200 pounds by the pumps. There are two Holly pumping engines with a capacity of 1,500,000 gallons per day each. The works have been constructed by Messrs. Samuel R. Bullock & Co., New York City under the supervision of the chief engineer, E. F. Fuller, M. Am. Soc. C. E., Denison; the superintendent, E. W. Abendroth, New York City, and M. J. Fitzgerald. The works are owned by the Denison Water Co., and cost $200,000.

TO PREVENT FREEZING IN WATER PIPES.—Dr. W. G. Browne, of Atlanta, Ga., has patented a contrivance for the automatic cut-off of water-service pipes when these are in danger of freezing. The device is a simple combination of four upright bars constructed of alternate layers of brass and steel, these bars are joined at the top, the two inner ones are jointed at the bottom and the two outer ones are spread apart at the bottom and are controlled by an adjusting screw. They operate by the contraction of the metal under exposure to cold drawing together the bars at the top of the pyramid; when a certain point is reached, fixed by the adjusting screw, the bar which supports the cut-off valve slips from its socket and drops down, thus releasing a weight which drops down and cuts off the supply and opens a relief valve which drains out the water in the pipe. The apparatus is applied at or near the water meter or at any point on the entering pipe before it reaches the house. Tests of this machine are said to have been very satisfactory.

PHILADELPHIA, PA.—The Councils' Committee on Surveys has had under consideration the estimated expenses of the Survey Department for the year 1887, which were fixed at $509,706, being $41,593 in excess of the appropriation made for 1886. The actual money given the department during the present year was $980,913.67, which included these sums taken from the surplus of gas loan No. 9 last May: $300,000 for Market street bridge, $93,000 for main sewers, $50,000 for completing the intercepting sewer, and smaller items for other purposes to the amount of $80,000.

The schedule submitted three new items; $125,000 for constructing a sewer to drain the valleys of the Wissahickon creek and Paper Mill run into the intercepting sewer; $50,000 for sewers in Manayunk of the dual character for house drainage and for storm water, each to connect with the intercepting sewer, and $30,000 to be devoted to the examination and re-construction of old sewers with manholes and ventilators. It was also asked that these items be submitted to the Finance Committee: For construction of main sewers, $150,000, and for branch sewers, $75,000.

A discussion as to the propriety of special legislation in giving a fixed sum for a particular sewerage system in any one district resulted in the figure being fixed at $325,000 for all such constructions, with opportunities thus offered each councilman to favor his ward by the early passage of drainage ordinances next year if the Finance Committee does not reduce the sum asked for.

BINGHAMTON, N. Y. There is much excitement over the alleged contamination of the city water by sewage from the great sewer which runs from the State Insane Asylum. This sewer was constructed by the State two years ago and was run past the water-works with the consent of the city, the State officials agreeing to so construct the sewer that it should not leak.

LONDON, (ENGLAND) DISTRIBUTING SYSTEM.—The number of miles of streets at present containing mains constantly charged, from which constant supply could be given, and upon which hydrants for fire purposes could be fixed, in each district of London, is as follows: Kent, about 85 miles; New River, about 251; East London, 180; Southwark & Vauxhall, 160; West Middlesex, 107; Grand Junction," 82; Lambeth, 217¾; Chelsea, 74; making a total length of about 1,156¼ miles. The companies are ready to give constant supply and to affix hydrants whenever legally required to do so.

CHICAGO'S WATER SUPPLY.—Dr. Rauch, Secretary of the State Board of Health, has prepared a long report on the results of chemical examination of Chicago water from September 1885, to September, 1886. Chemical analyses of water from differett points, and measurements of the water in the canal and river were made by the canal officials. The report contains tables of the rainfall, the course and power of the wind, measurements of the Chicago level, which is practically the level of the lake, and the difference of level of the water in the lock, which gives some idea of the amount of water thrown into the canal by the pumps at Bridgeport. No sewage from Chicago was detected in the canal beyond the Kankakee feeder. The report shows that when the pumps at Bridgeport discharge 50,000 gallons of water per minute into the canal, the Chicago drinking water is kept free from contamination.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

(For further items see page XV.)

The International Cable Co., capital $5,000,000, has been incorporated in London, England, to lay cables from England to the Azores, the West Indies, New York and Canada.

Pennsylvania R.R.Co.—President Roberts has made a proposition to the authorities of Jersey City, N. J., to elevate the company's tracks through the city. Four tracks to be raised and to be carried on iron columns and trusses; the cost is estimated at about $900,000. Work will be commenced at once if the city will alter certain street grades, and close Greene street near the present depot.

Main Canal.—The completion of the canalization of the river Main was celebrated at Frankfort, Germany, November 13th. The river has been turned into a navigable waterway, 22 miles long, from Frankfort to the confluence with the Rhine, with a depth of from six to eight feet. The largest Rhine boats of 1,000 tons can now go from the Lower Rhine to Frankfort direct, without lightering at Mayence as formerly. A harbor has been constructed at Frankfort capable of holding 60 boats 230 feet in length. The total cost of the canal and harbor was $3,000,000.

Hell Gate.—Lieut. Col. McFarland, U. S. Engineers, states that 18,288 pounds of dynamite were used in removing obstructions at Hell Gate and in the East river, and 28,622,313 pounds of rock were raised. The estimated cost of the improvements in progress, $500,000 of which Col. McFarland states could be profitably expended in the year ending June, 1888. Bids for the removal of the debris were received at Washington, recently, from several dredging companies, the bids ranging from $200,000 to $290,000; all were rejected as excessive and new proposals will be advertised for.

A New Form of Railroad.—The *Railway and Tramway Express*, London, England, announces that a new system of railroad has been patented, by which trains will be able to travel at double the present speed. The train travels within an open iron-work frame; grooved wheels, with adjustable springs, are fitted to the roofs of the cars and bear against rails fixed in the upper corners of the frame, so as to prevent oscillation and keep the train from leaving the track. The trains are said to be light and strong, rendering the cost of construction considerably less than with the present system, and effecting a saving in fuel. The engine and first car are built on the same frame; the engine has large driving wheels.

Economy on the Reading R. R.—President Corbin proposes to lease to other companies the thirty-seven furnaces owned by the company in the Schuylkill valley; lease its iron-ore property in the Cumberland valley, in Virginia and in New York; to save $250,000 per annum in the manner of handling coal at tide-water; to abolish the London and New York offices; to dispose of

idle property; cut down the extraordinary legal expenses; do away with the company restaurants. These economies are expected to amount to $2,000,000 per annum. The company also proposes to be at peace with other companies and is now considering the propriety of leasing its collieries.

A City Without Money.—Mayor Guillotte, of New Orleans, La., says he will recommend the suspension of all city officials during December, as far as pay is concerned, and expects they will submit; he acknowledges that it is hard but cannot be helped. The city is utterly unable to pay any but the most necessary and urgent expenses, such as for feeding prisoners, and horses and paying for hauling the garbage. The street and bridge gangs, laborers, police, and prison officers will have to work without pay. The city cannot create a floating debt, and unless they do this the men cannot be paid. The Mayor will have to lose his own salary, he says, and he is by no means a rich man. What the Council will do in the matter he does not know, but he will certainly recommend the suspension of all employes. Most of them, he thinks, will work during December without pay in order to retain their positions.

The Tay Bridge, according to the report of the North British Railway, is nearly completed. The plans of Mr. Barlow, as engineer, were approved by directors in March, 1881, the fall of the original bridge having happened on December 28, 1879. The new bridge provides four spans of 245 feet each, for the navigation of the river, with a clear headway of 62 feet instead of 88 feet as in the old bridge; the bridge is on a uniform gradient of 1 in 180, while the old bridge had gradients as sharp as sharp as 1 in 74. North of the navigable spans are now eighteen spans, instead of nine as formerly, with the track above the girders. The piers are concrete and brickwork up to 8½ feet above high water, and above that they are made of riveted wrought-iron; the bridge terminates at each end in brick arches. The contract for the new viaduct was let in 1882; the total expenditure on the new work, including the removal of the wreck and old piers, will not fall short of $5,000,000.

Contracting.

(For further items see page XIII.)

Street Work.—At San Francisco, Cal., contracts have been awarded to H. C. Partridge for paving at 23 cents per square foot, and for crosswalks at $1.10 per lineal foot.

Rock.—At Leavenworth, Kan., M. Stanton has the contract for rock for the city jail at 70 cents per cubic yard.

Dredging.—The following bid has been received by Major M. B. Adams, U. S. Engineer Office, Burlington, Vt., for dredging 50,000 cubic yards of material and removing three boulders in Ogdensburg harbor, N. Y.: William J. Daly, Ogdensburg, N. Y., 16.9 cents per cubic yard, $250, total amount, $8,700.

Dredging.—Proposals for dredging in Mosquito creek for improving the Santee river, S. C., received by Capt. W. H. Bixby, U. S. Engineers, November 20: Charles H. Lewis, Baltimore, Md., 40 cents per cubic yard (irregular;) Rittenhouse Moore, Mobile, Ala., 37 cents. Specifications and forms of proposals were sent to 31 contractors.

Rip-Rap Stone.—The following bids for rip-rap stone on the Potomac river improvement work, have been received by Lieut. Col. Peter C. Hains, U. S. Engineer Office, Pennsylvania avenue, Washington, D. C.; No. 1, for 20,000 cubic yards, No. 2, for 12,000 cubic yards G. Vanderwerken, Washington, D. C., No. 1, $1.03; No. 2, 93 cents; H. P. Gilbert, Washington, D. C., No. 1, $1.03; No. 2, 95 cents. The contract has not yet been awarded.

Harbor Work.—The following are the bids for improving the harbor at Sabine Pass, Tex.; the bids are for brush mattress per cubic yard, sandstone rock per ton, granite rock per ton, and oyster shells per ton, respectively: A. M. Shannon, Galveston, Tex.: $1.75, $4, $4.80, $1; Wm. Fagan & Robert A. Wilson, New Orleans, La., $1.62½, $5, $4.80, $1.75; Louisiana Jetty & Lightering Co., New Orleans, La., $1.55, $3.90, $4.25, 50 cents.

Asphalt Paving.—Proposals opened November 23rd by Lieut. Col. John M. Wilson, U. S. Engineers, for roadways and footwalks in the public grounds at Washington, D. C.; bids per square yard: H. L. Cranford, Washington, D. C., asphalt roadway pavement, $2; Trinidad asphalt footwalks, $1.35; Vorwohler mastic footwalks, $1.85; Neuchatel mastic footwalks, $2.70. Schillinger Co., Washington, D. C., Vorwohler mastic footwalks, $1.90.

Street Work.—The following bids were opened at Baltimore, Md., November 15th, for grading per cubic yard, curbing per lineal foot, and paving per square foot: Edward Heffner, Jr., 10 cents, $1, 4½ cents; Thos. S. Lyon, 10, 37 and 4½ cents; Patrick Reddington, 8, 90 and 4½ cents; Owen Patterson, 10 cents, no bid, 4 cents; James P. McGovern, 9½ cents, $1.10, 4½ cents; William R. Weaver, no bid, $1.10, 4.1 cents. The bids for repaving ranged from 1¾ cent to 2½ cents per square foot The contract was not awarded.

Panama Canal.—A judgment by default was entered in the County Clerk's office of New York on Nov. 22, against La Compagnie Universelle du Canal Interoceanique du Panama in the sum of $653,296 on the application of Robert P. Lee, Receiver for the Franco-American Trading Company, Limited. The trading company had furnished labor for building the Panama Canal to the value of $1,535,000, and had received in payment only $896,600. The judgment asked for was for the balance of the account, with costs and interest.

Dredging.—The following bids for dredging in Washington channel, for the improvement work on the Potomac river, have been received by Lieut. Col. Peter C. Hains, U. S. Engineer Office, Pennsylvania avenue, Washington, D. C., and opened November 20th; the quantity is about 400,000 cubic yards: American Dredging Co., Philadelphia, Pa., 19.9 cents per cubic yard; National Dredging Co., Wilmington, Del., 20.9 cents; Morris & Cummings Dredging Co., New York City, 22 cents; Benson & McNee, San Francisco, Cal., 16.5 cents; Rittenhouse Moore, Mobile, Ala., 13 cents. The contract has not yet been awarded.

Dredging.—Proposals opened November 23rd, by Lieut. Col. Walter McFarland, for work in New York harbor; the prices per cubic yard and the total amounts are given: GOWANUS BAY, 40,000 cubic yards.—Elijah Brainard, 32 cents, $12,800; Morris & Cummings Dredging Co., 32.5 cents, $13,000; Henry DuBois Sons, 33 cents, $13,200; W. B. Beard, 34.5 cents, $13,800; P. Sanford Ross, 35 cents, $14,000. BUTTERMILK CHANNEL, 170,000 cubic yards.—U. S. Dredging & Canal Construction Co., 23.3, $39,666.66; Henry DuBois Sons, 29.5 cents, $50,150; P. Sanford Ross, 32 cents, $54,400; Morris & Cummings Dredging Co., 33 cents, $56,100; Elijah Brainard, 38 cents, $64,600; W. H. Beard, 38 cents, $64,600.

Garbage Disposal.—The contract for removing the garbage of Brooklyn, N. Y., has been awarded to Henry Berau for five years, his being the lowest bids as follows: For burning the garbage—first year, $85,000; second year, $85,000; third year, $75,000; fourth year, $70,000, and fifth year, $70,000. For removal by boat—first year, $66,000; second, $65,000; third, $60,000; fourth, $55,000; fifth, $55,000. To be taken one mile beyond the city limits—first year, $75,000; second, $65,000; third, $60,000; fourth, $60,000; fifth, $60,000.

The contractor will commence work on his contract December 1st, and will probably remove the garbage by boats during the winter; the commissioners have the power to compel him to adopt either method at their pleasure. A complete list of the proposals was given in our issue of November 13th.

Breakwater.—The following bids for stone for the breakwater at the mouth of the Saco river have been received by Major Jared A. Smith, U. S. Engineer Office, Portland, Me.; the bids are for first and second-class stone per ton, and for securing the beacon: Isaac H. Webber, Chebeague, Me., $1.15, $1.15, $75; John T. Hamilton, Portland, Me., $1.12, $1.12, $50; George Willett Andrews, Biddeford, Me., 98 cents, 98 cents, $10.25; Joseph A. Curitt & Alfred E. Hamilton, Chebeague, Me., $1.07, $1.07, $30; John A. Hamilton, Chebeague, Me., $1.29, $1.29, $100. The contract has been awarded to George W. Andrews.

Stone.—The following bids for removing rock ledge have been received by Major Jared A. Smith, U. S. Engineer Office, Portland, Me.; PORTSMOUTH HARBOR, N. H., George W. Townsend, Boston, Mass., $18.97 per cubic yard; Thomas Symonds, Leominster, Mass., $19.25; Solon S. Andrews, Biddeford, Me., $26; Isaac A. Sylvester & Thomas A. Rowe, Boston, Mass., $27.87; Edward R. Lowe, New York City, $28.75. The contract has been awarded to George W. Townsend, COCHECO RIVER, N. H., Thomas Symonds, Leominster, Mass., $9.50 per cubic yard for ledge, $4.50 per cubic yard for boulders; George W. Townsend, Boston, Mass., $9.50, $5; Solon S. Andrews, Biddeford Me., $14.50, no bid; B. G. Bailey, 16-18 Exchange place, New York City, $19, no bid. The contract has been awarded to Thomas Symonds.

City Contract Frauds.—The Brooklyn *Eagle* recently printed despatches announcing the exposure of a system of fraud to enrich certain contractors and city officials from the $4,000,000 appropriations for street improvements at Cincinnati, O. The specifications were drawn up last year by the Board of Public Works and the bids were sent to the city engineer to be computed and reported upon. Before they were computed the prices $1.00 and 30 cents for crushed boulders and grading were altered respectively to $1.99 and 99 cents; the alteration being made by a city official who received a percentage of the total increase of cost caused by the change. It makes a difference of $7,000 on one street. City Controller E. Shelby refused payment on November 20th, on account of the discovery; M. S. Forbus, the contractor, denies all knowledge of the fraud. The Board of Public Affairs will make an investigation.

The Montreal Contractors Builders' Association held its first annual meeting on November 10. President, Mr. Louis Allard; Vice President, Mr. Rutherford; the office is at 99 James street, Montreal.

THE INDUSTRIAL SITUATION.

The present month has been the most active month of this year with buyers of material. Railroad builders have placed orders for no less than 150,000 tons of steel rails, and no less than 50,000 or 60,000 tons of foreign steel rail blooms, ingots and slabs. Several heavy orders have been placed for freight, coal and gondola cars. All the car-builders without exception are well supplied with orders, some of which will run into mid-winter at least. Nearly all the leading railway companies in the country are in the market for supplies of one kind or another. More railway construction is projected at this time than at any time in the history of railway building. Various estimates have been made as to the volume of projected construction but many of them are guess work. The improving industrial conditions of the past few months have stimulated a great deal of enterprise which has been latent for two or three years. No difficulty has been met with in borrowing money. Investors have been rather disappointed of late years at the limited encouragement from legitimate enterprises. Capital is seizing the present opportunity with earnestness. This year's mileage is about double that of last and if the statistics of side tracks and feeders could be had it is probable that it would be shown the construction this year was much more than double. Nearly all of the trunk lines and many large Western lines have constructed short feeders for the development of intermediate traffic which have not been reported in the general makeup. As to next year's construction there is no difference of opinion among railroad builders and rail makers that it will be the most active year on record. The reasons for this statement are that already nearly one-half, some say altogether one-half, of next year's rail production is under contract and that there are a volume of inquiries which rail makers are disposed to discourage for the present. In addition to this several large contracts have been placed in foreign mills, and as above stated large orders for steel rail blooms have been placed in foreign mills for shipment to American mills, other than Bessemer, to be worked into rails. The estimated Bessemer capacity is 1,500,000 tons. There is no doubt but this entire capacity will be sold months before the material could be delivered. Even at 100 tons to the mile this calls for 15,000 miles of road. Repairing requirements will consume a large portion of it. If no financial disturbances occur a multitude of new railway enterprises will take shape next year. Proof is to be found among locomotive makers, bridge builders, car-builders and the manufacturers of small railway machinery and supplies as to the correctness of the sanguine anticipations concerning next year's work.

The iron and steel industry throughout the country is in a very vigorous condition and nearly all productive capacity is sold up for weeks and months to come. The pig iron capacity is estimated at not less than 122,000 tons per week. The rail capacity at 30,000 tons and the rolled iron capacity at nearly 45,000 tons per week. The locomotive makers have been the last to feel the stimulus but within the two months past nearly all the well-equipped works have booked orders ranging from five to twenty-five engines which the managers believe is but the beginning of demand for locomotive capacity which will keep them busy for some months.

The upward tendency of prices in material and manufactured products of all kinds which began to manifest itself early in the fall still continues and has not as yet produced any unfavorable results. On the contrary the hardening tendency has encouraged demand and stimulated production without creating a speculative demand nor crowding prices above a safe and healthy limit. Bar iron mills are oversold at from 1.70 to 2 cents. Steel rail quotations range from $34.50 to $36; plate iron 2.25 to 2.50 cents; structural iron from 2.10 to 3 cents; crude iron from $17 to $20 for foundry and $16 to $17 for forge. Producers and buyers of iron and steel are deeply interested in the present market situation. Manufacturers are endeavoring to legitimately establish prices for the coming year at the present high limits reached. Consumers are naturally indisposed to assist them in so doing and are therefore purchasing only for current requirements until producers test their ability to exact the highest figures named. The general trade outlook is certainly very gratifying and there is nothing in the situation to weaken the confidence of investors and manufacturers. The railroads are increasing their traffic and their earning capacity; manufacturers are improving their plants and preparing for an increased output. Labor is less threatening in its demonstrations and a more friendly relationship is being established between employers and employed, producers and consumers.

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials.

WHOLESALE PRICES.

New York, November 25, 1886.

IRON.

STRUCTURAL IRON.		
Angles	2.15c @	2.25c
" steel	2.45 @	2.60
Tees	2.50 @	2.60
Beams and channels, American	3.00 @	
Tank plates	2.25 @	2.35
Shell plates	2.50 @	2.60
Steel plates, Tank	2.70 @	2.75
WROUGHT-IRON PIPE. PITTSBURG.		
Butt welded, black ..... Discount		40
" " galvanized ..... "		30
Lap welded, black ..... "		52½
" galvanized ..... "		35
Boiler tubes ..... "		45
RAILS.		
Steel (large lots at mill)	$34.00 @	$35.00
Old rails	22.25 @	23.00
Old rails, steel	22.0½@	23.00
R. R. spikes	2.15c @	2.20c
R. R. spike-plates	1.70 @	1.90
R. R. track bolts, square nuts	2.50 @	2.75
Barb-wire fencing, galvanized	3.85 @	3.90
" " painted		4.00
Corrugated iron		
Nails		
Iron, per keg	1.95 @	2.00
Steel do.	2.10 @	2.20

METALS.

COPPER.		
Lake Superior	11.50 @	11.90
Other Brands	10.37	
LEAD.		
Com. Domestic	4.00 @	4.25
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.50 @	5.70

BRICK.

Cargoes (afloat)		
Choice Brands	7.75 @	8.00
Haverstraw ..... per M.	7.00 @	7.75
Fishkill	7.00 @	7.25
Up-River	6.75 @	7.00
Jerseys	6.25 @	6.75
Long Island		
Pale	4.75 @	5.00
FRONTS.		
Croton, red	13.00 @	15.00
" dark	13.00 @	15.00
" brown	12.00 @	14.00
Philadelphia pressed	27.00 @	28.00
Trenton "	27.00 @	28.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	85.00 @	130.00
" American	80.00 @	120.00
Fire brick	25.00 @	55.00
American, No. 1	30.00 @	35.00
" No. 2	25.00 @	30.00

ASPHALT.

ROCK.		
French, per ton	$22.00 @	25.00
German	15.00 @	20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50 @	$3.00

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85 @ .90
" finishing	1.05 @ 1.10
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95 @	1.00
" " No. 2 "	0.75 @	0.85
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "		
Brown stone, Portland, Ct. "	1.00 @	1.35
" Belleville, N. J. "	0.75 @	1.35
Granite, rough	0.45 @	1.25
Common building stone per load	2.00 @	3.00
Ice stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square.	5.00 @	6.00
Green "	5.00 @	6.00
Red "	10.00	
Black Penna. (at New York) "	3.50 @	4.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00 @	20.00
Choice "	65.00 @	70.00
Tally plank, 1¼ in. 10 in. dres'd. each.	.44 @	.50
Tally boards, dressed com. "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	14.00 @	16.00
HEMLOCK, Boards each.	.14 @	.16
Joist, 2¼ × 4 to 4 × 6 in	.16 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	25.00 @	30.00
Dressed flooring "	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate "	2.25 @	2.30

PAINT.

Lead, white, American dry per lb	.04¾ @	.06½
" " in oil pure "	.07 @	.07½
" English, B. B. in oil "	.08½ @	.08¾
" Red, American "	.06½ @	.07
Litharge "	.05½ @	.06
Venetian red, American "	.01 @	.01¼
Indian red "	.08 @	.10
Vermillion, American lead "	.10½ @	.11½
Paris green "	.15 @	.18
Umber, Amer. raw and powdered per lb.	.01¼@	.01¾
Drop black, Amer. "	.07 @	.18
" " Eng. "	.11 @	.13
Chrome green "	.10 @	.25
Oxide zinc, American "	.03¾ @	.03½
" French "	.05½ @	.07½

CEMENT.

The following price currents is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MEYERSTEIN:		
Hanover Port.and	$2.60 @	$2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25 @	2.50
Fewen	2.25 @	2.50
BROOKS, SHOOBRIDGE & Co.	2.45 @	2.60
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40 @	2.75
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50 @	2.75
" K. B. & S. " "	2.25 @	2.50
Stettiner, German	2.65 @	2.85
Lagerdorfer, "	2.45 @	2.75
Fieve, A 1, Belgian	2.35 @	2.50
Roman	2.75 @	3.00
Keene's Coarse	4.75 @	5.50
" Fine	7.75 @	8.50
" Superfine	8.50 @	10.00
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15 @	2.45
EMIL LENZ, New York.		
Stettin Portland	2.35 @	2.55
Fire-proof	1.75 @	1.95
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20 @	2.40
Improved "Union"	1.25 @	1.50
Union	1.10 @	1.20
NEW YORK CEMENT CO.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT CO.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35 @	2.85
K. B. & S.	2.25 @	2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90 @	3.25
UNITED STATES CEMENT CO.:		
English Portland	2.25 @	2.40
German	2.00 @	2.15
Standard	1.80 @	1.65
Windsor and Improved Rosendale	1.00 @	1.10
UNION AKRON CEMENT CO.:		
Akron "Star" brand	1.00 @	1.10

MARKET SUMMARY.

The week's business in Building Materials show little variation in prices and a good condition of trade. Brick are in good demand and move rapidly at $7.75@8.00 for choice Haverstraws, $7.50@7.75 per M. for Firsts, and $7.00@7.25 per M. for Seconds. Fishkill fetch $7.00@7.25 and other Up River makes, $6.75@7.00 per M. Pale are in active demand at $4.75@5.00 per M., with occasionally a slight advance in the latter price. Jerseys are sellingat $6.25@$6.75, an increased demand for Front brick is noticed and Philadelphia and Trenton are firm $27.00@28.00 per M. alongside pier; the demand for Terra-Cotta is also large. Rosendale Cement is in request at $1.10 per barrel, and manufacturers find it difficult to keep the supply equal to the demand. Portland Cement is without change, importations are beginning to moderate in volume as the season for outside work in artificial stone work has almost closed. Lime has been scarce, arrivals this week are the first since November 12, and have been at once secured by dealers at prices of $1.00 for Common Rockland, $1.20 for Finishing. Plaster and Hair show no change in figures and are in good demand. The Lumber Market shows a healthy condition. Spruce Lath have sold at $2.25@2.30 per M., and sales have been made as high as $2.35 per. M., but this would not be a fair quotation unless for a small lot, particularly desirable. Spruce Timber sells at $14.00@$16.50 per M. for good random cargoes, with extra special schedules as high as $18.00. Yellow Pine has proved very regular in prices, random cargoes are quoted $17.50@19.50per M., Specials $19.50@$21.00 per M. Green Flooring boards $20.00@22.00, and Dry $23.00@26.00; some activity is noticable in White Pine which is now quoted at $16.00@$17.00 for West India shipping boards, $24.00@$29.00 for South American; $13.00@$14.00 for box boards, and $15.00@$17.00 for extra. Hardwoods are in good demand with a fair export demand. Walnut is worth $60.00@$110.00 per M. Chestnut $28.00@$32.00, Cherry $72@$80.00, Maple $20.00@$32.00. Paints and Oils show no change in figures. Turpentine 36½c.@37c. per gallon. Lead quiet and steady with price for domestic still 4½c. Tin is dull but steady at 22.45c.@23.60c. spot, 22.50c.@22.70c. for futures. Copper firm at 12c.@12.15c. The Hardware Market continues dull and no changes in prices are reported, except in wrought-iron pipe on which the new discounts are as follows;—Butt-weld black, 40 per cent.; lap-weld black, 55 per cent.; butt-wel: galvanized, 30 per cent.; lap-weld galvanized, 3½ per cent.; all car load lots, while for less than car load lots the discounts are 37½ per cent., 50 per cent, 27¼ per cent., and 32½ per cent., respectively, for the descriptions above named. Nails continue to sell at $1.95@$2.00 per keg for 10d@60d. with occasional discounts. Plate Glass is in good request, and Foreign and American Window Glass in demand with some irregularity in discounts.

BUILDING ITEMS.

The two buildings adjoining the Mutual Life Insurance Co. are to be torn down, and it is rumored will be the site for an extension to that imposing edifice.

Messrs. Thom & Wilson are the architects for a five-story brick apartment house, to be built on the south side of Seventy-fourth street from Tenth avenue to the Boulevard; it will be 131.2x120.11 on the Avenue and 132.11 on the Boulevard, and is to be built by day work, for Mrs. Hannah Lee Powers, of Peekskill, N. Y., at an estimated cost of $150 000.

Mr. W. P. Anderson is the architect for seven three-story brick tenements, 20x50, to be built on the south side of One Hundred and Forty-fourth street, 210 feet east of Eighth avenue for Mrs. Mary E. Carlin, at a co t of about $100,000.

Messrs. Marshall & Walter have prepared plans for the alteration of the dwelling on the southeast corner of Seventy-second street and Second avenue into a flat with stores at a cost $8,500; Maurice Moore, 43 New street, owner.

Mr. Wm. E. Mowbray has designs for four three-story and basement brick residences, 20 and 21x55, which he proposes to build at an expense of $65,000 on the northwest corner of Convent avenue and One Hundreth and Forty-fourth street.

Messrs. A. Pfund & Son have designed for Jacob Hoffmann an extension to ice house in rear of 204 East Fifty-fifth street, to cost $3 000.

Messrs. A. B. Ogden & Son have prepared plans for six five-story brick flats with stores, 25x72 each, to be built for Robert Betty and Samuel Edgar on the south side of Seventy-first street, 150 feet east of Second avenue, at a cost of $100,000, also for a six-story brick flat with stores, 31.6x81, to be built at No. 9 Christopher street for John Davidson, at a cost of $40,000, and a brick, stone and terra-cotta store, to be built at No. 43 Mott street, at a cost of $22,000.

Mr. Charles Baxter has on the boards plans for a three-story and basement brick residence, to be erected for Frederick Meyer on the south side of One Hundred and Forty-fourth street, 375 feet east of Eighth avenue, at a cost of $12,000.

Mr. A. Page Brown, 57 Broadway, ha prepared the plans for alterations to the Bethesda Episcopal church at Saratoga Springs, which will cost $25,000.

Mr. R. H. Robertson has on hand designs for a cottage, to be built at a cost of $15,000 for Bowles Colgate at Monmouth Beach, N. J.

Mr. R. Napier Anderson has designed a store, to be built at No. 138 Fifth avenue for Hardman, Peck & Co., at a cost not yet estimated.

Mr. F. F. Ward has prepared plans for two cottgaes, to be built at Roseville, N. J., for Dr. George A. Van Waganen, at a cost of $9 000.

Messrs. Napoleon Le Brun & Son have designed for the Commissioners of Charities and Corrections a bakery, to be built on Ward's Island. Estimates for its construction will be received until December 1st.

Mr. Jos. M. Dunn has prepared plans for additions to the National hotel, Far Rockaway, for P.B. Caslin, to cost $10,000.

Mr. Wm. Rabenstein has decided to build on the northeast corner of Willis avenue and One Hundred and Thirty-seventh street, five brick flats with stores, to cost about $50 000.

Mr. A. H. Blankenstein has drawn plans for six five-story brick and stone tenements, 25x72 each, to be built for Peter Keher on the east side of Goerck street, 70 feet north of Stanton street, at a cost of $90,000.

Mr. Joseph Schwarzer will erect on the east side of Washington street, 20 feet south of Twelfth street, two five-story brownstone flats with stores, to cost $35,000.

It is anticipated that the De La Salle Institute on Second street, will move further up-town, and steps have been inaugurated to raise funds to allow of a building being erected, to cost, including the land, $200,000.

The price of Statistical Tables of American Water Works is Two DOLLARS: *free* copies will be sent only to advertisers, Water Works offices, to parties who give us information for future use, and to the press. The advanced demand will influence the edition somewhat; our aim is to comply with the terms of our contract with advertisers most thoroughly; the margin of profit to us is so small, however, that we do not care to lessen it with an unnecessarily large edition which is of little value as soon as a new edition is announced.